



TELE SCAR

Tele-Scar System Proposal - Report

Telemedicina e E-saúde

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Catch - 22

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Abstract

Diabetic foot ulcers (DFUs) are one of the most common and feared complications of diabetes leading to amputation, disability, and mortality. To reduce the incidence and consequences of foot ulcers all diabetic patients must be followed by a multidisciplinary team of health care professionals. Although all team members influence the management and treatment of the wounds, the role of nurses and podiatrist are essential. Both have an important role in patient education, patient care (examination and screening), and treatment, however with somewhat different approaches.

The treatment of DFUs puts great pressure on the health care systems, which represents an opportunity for telemedicine (TM) and digital technologies.

In the present work a monitoring system was designed – Tele-Scar Platform – to assist patients with diabetic foot ulcers in the management and care of their wounds.

The mobile app allows images to be captured and sent through a secure two-way communication system to the clinician portal. Based on the received data the clinician (nurse) can monitor the patient's adherence to self-care tasks, provide recommendations on how to care for the ulcer, and send it to the patient's app. The mobile app in the Tele-Scar platform is not limited to image capture and is designed to support self-care by patients, with reminders and education, enabling an individual to acquire the knowledge and skills required to successfully self-manage his/her condition and improve outcomes.

It should be noted that this system is intended to be used for monitoring and provide care to patients with superficial ulcers in a similar approach to that seen in the first level of care.

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Chapter 1 – Introduction

1.1. Focus

Diabetes mellitus (DM) is a group of chronic metabolic disorders characterized by hyperglycemia resulting from defects in insulin secretion, insulin action or both, imparting loss in health and economic burden on patients and healthcare systems around the globe [1], [2].

Diabetic foot is one of the most significant and devastating complications associated with DM and is defined by the World Health Organization (WHO) as “a foot in diabetics with neurologic disorders, some degree of vascular involvement with or without metabolic complications of diabetes in the lower extremity and prone to infection, scarring, with or without deep tissue damage” [1], [3].

A diabetic foot ulcer (DFU) is an open sore or break in the foot and frequently serves as a portal for infection (Fig.1). The most significant risk factors for developing a foot ulcer are diabetic neuropathy (DN) – most common factor in almost 90% of diabetic foot ulcers, peripheral arterial disease (PAD), and consequent traumas of the foot [1], [4]. Diabetic neuropathy is defined as an impairment of normal activities of the nerves throughout the body, affecting the motor, sensory, and autonomic fibers [4].



Fig. 1. Diabetic Foot Ulcer (DFU). Excessive stress on plantar tissue over time and loss of protective sensation are leading causes of DFUs. Adapted from [1].

Perhaps the most recognized form of neuropathy among patients with diabetes is sensory neuropathy - loss of the protective sensation of pain, pressure, and heat. This loss of sensation in the feet may lead to smaller injuries that if not detected at an early stage may consequently lead to foot ulceration and potentially to foot amputation [1], [4]. This is particularly important for patients with PAD, presenting a 71% increased risk for failure to heal their ulcers and a 61% increased risk for infection compared to those foot ulcer patients without PAD [5].

Other risk factors for foot ulceration include a previous history of foot ulceration or amputation, poor glycemic control, smoking, age, and the duration of diabetes. Social factors such as low socioeconomic status, poor access to healthcare services, and poor education are also proven to increase the risk of DFUs [1], [4].

DFUs can lead to chronic infection, severe forms of gangrene, amputation, and even death if the necessary care is not provided [1].

According to the protocol in diabetes care recommended by the American Diabetes Association (ADA), one of the preventive tactics is a multidisciplinary team of healthcare professionals [3].

The members of this multidisciplinary approach are usually general practitioners, nurses, orthopedists, podiatrists, endocrinologists, vascular surgeons, etc., bringing a set of skills and knowledge that contribute to increasing the chance of successful healing and prevent recurrence [3], [6], [7].

Following the Regulation no. 005/2011 of 21st January of the Direção Geral da Saúde – DGS, the diabetic foot care teams should be organized according to three levels of care: levels I, II, and III with an increasing number of professionals involved (Table 1) [8], [9].

Table 1. Diabetic foot care team organization according to levels of care

	Levels of care		
	Level I	Level II	Level III
Wound	Superficial Ulcers	Ulcers with a sign of infection and/or necrosis	Ulcers with a sign of infection and/or necrosis
Intervention	Patient education, preventive measures, risk assessment, monitorization, provision of care and treatment	Surgical intervention - debridement with hospitalization	Vascular assessment and vascular surgery
Diabetic Foot Care Team	Nurse, General Practitioner, and Podiatrist	A more complex team including an Endocrinologist, an Orthopedist, a Clinical Nurse Specialist in podiatry, a Podiatrist and a General Surgeon	Same as seen in level II with the addition of a Vascular Surgeon, a Physiatrist and an Orthotist

In level I is performed the management of superficial ulcers. Its main objectives are patient education, risk assessment, monitorization, implementation of preventive measures, and provision of care and treatment. At this level, each ACES (Agrupamento de Centros de Saúde) should have a team composed of a nurse, a general practitioner, and a podiatrist. The other two levels are related to the treatment of more complex wounds, often with signs of infection and/or necrosis (level II), requiring vascular assessment (level III) and possibly surgical interventions [8], [9].

Key factors of appropriate management of a DFU include weekly or bi-weekly treatment at the outpatient foot clinic [10], [11], adequate wound debridement (removal of dead tissue helps in faster the ulcer healing) [4], wound dressing and off-loading strategies (custom footwear/orthotics) recommended by the podiatrist [4], [6].

The prevention of diabetic foot is crucial, considering the negative impact on a patient's quality of life.

1.2. Motivation and Objective

Nonhealing DFUs are the most general cause of hospitalization in diabetic patients. Globally, it is estimated that 20 million people currently have an active DFU with a further 130 million either having a history of DFU or the precursor risk factor of diabetic peripheral neuropathy and expected to develop a DFU in their lifetime if no intervention is performed [12].

Perhaps no subsequent complication of DFU is more significant than its associated 10%-20% rate of lower extremity amputation per event [12]. At least 85% of such amputations are potentially preventable with appropriate care and education [1]. The consequences of DFU are not limited to amputation since they put people at risk for other adverse events such as falls, fractures, reduced mobility, social isolation, depression, unemployment, and mortality [4], [8].

In addition to the mortality and morbidity associated with DM, foot lesions represent an economic burden on the healthcare system [2]. Diabetic foot care costs represent the single largest category of excess medical costs associated with diabetes - it is estimated that one-third of all diabetes-related costs are spent on diabetic foot care in the United States - and may vary according to the interventions used and management approaches [2], [12].

With the global prevalence of diabetes mellitus projected to almost double from a baseline of 2.8% in 2000 to 4.4% by 2030, affecting over 350 million individuals, managing diabetes at the level of the individual patient is becoming increasingly challenging [1], [13].

Since diabetes care is largely dependent on patient self-management, it represents an opportunity for telemedicine (TM) and digital technologies to assist in the effective management of DFUs and limit its consequences.

Smith-Strom et.al. [14], have suggested that use of TM by enabling easier counseling and communication between health care professionals (community nurses and specialist health care) can be a relevant alternative and supplement to usual care, at least for patients with more superficial ulcers.

Most physicians and patients agree that foot care is the most desirable clinical strategy, preventing lower extremity ulceration, infection, and amputation, with some studies showing that this approach is either highly cost-effective or cost-saving [1], [11]. Therefore, efforts to empower patients to be part of the health ecosystem including preventing DFUs or taking care of their active DFUs are required. Recent advances in telecommunication technologies could facilitate the

provision of comprehensive feedback, recommendations (e.g., personalized and easy-to-understand guidelines to manage DFUs), and notifications to engage patients in self-care [15].

The main objective of this project is the design of a system – Tele-Scar Platform - for ulcer care monitoring, including photographic follow-up. This system is intended to provide a new way for healthcare professionals to partner and interact with their patients.

1.3. Workplan – SCRUM

To reach the main objective of the project, a workplan was defined according to the *SCRUM* method, an evolutionary and incremental approach to the development of a system [16]. Overall objectives or tasks were grouped in the project product backlog, along with any additional objectives brought up during project development.

Each week of the nine weeks' time of project development a *sprint* was created, and objectives from the product backlog were selected to be developed in that week's *sprint*. During the *sprint* were identify intermediate tasks that needed to be accomplished over the course of the week to meet the sprint's objectives.

If by the end of the *sprint* some of the tasks were not finished, i.e., were still in the “to do” or “in progress” phases those tasks would return into the product backlog to be developed in the next *sprint*, this process was repeated continuously until all the project objectives were completed.

A diagram of the project workplan according to the *SCRUM* approach is depicted in Appendix I – Sprint and Product Backlog.

1.4. Structure of the Report

This report is organized into four chapters. The first chapter presents the report context, topics under study, motivation, project workplan, and structure. Further chapters of the paper are organized as follows:

Chapter 2: State of the art – focus on related projects present in literature.

Chapter 3: Tele-Scar Platform – presents the requirements analysis of the system, main functional diagrams (use case diagram and activity diagrams), the package diagram of the system as well as the user interface prototypes.

Chapter 4: Conclusions and Future Work – concludes the report and presents directions for future work.

Chapter 2 – State of the Art

Although several telehealth and telemedicine applications have been developed over the years to improve the well-being and autonomy of people with diabetes, only a few have been implemented in diabetic foot care [11].

Developed applications include dermal thermography, foot imaging tools (hyperspectral and photographic), and audio/video/online communication technologies. Most of these approaches/technologies were used for prevention, assessment, monitoring, and treatment of diabetic foot ulcers with many studies showing their effectiveness or feasibility [11].

In most studies telemedicine systems were used for monitoring purposes and it were frequently used by trained nurses who were responsible for collecting the data and take digital images of the wound to be sent to a physician for decision making [17]. Similar projects include Sana a mHealth project from Massachusetts Institute of Technology (MIT) [18], and a telemedical intervention for diabetic foot ulcer monitoring implemented in Denmark [19].

In the latter study, teleconsultations were performed via telephone or e-mail between the visiting nurse and the physician, enabling knowledge and skills to be shared [19].

Although this approach proved to be beneficial for the visiting nurses, physicians were concerned with the lack of a multidisciplinary wound care team, since most of the decisions were performed by just one physician. Nurses were also concerned with the fact that this approach could make the patients less responsible and empowered to handle their disease, since most of the decisions were performed between them and the physician, without patients being directly involved. This lack of interaction with the physician was also was one of the concerns expressed by the patients [19].

The use of mobile apps, wearable devices, and smart sensors is being gradually incorporated in the care and education of patients with diabetes, an approach called digital therapy [13], [15].

The Society of Vascular Surgery mobile application (SVS iPG app) (Fig. 2B) provides education on different types of wounds and includes guidelines to manage each wound type. In addition, it includes a calculator for DFU classification based on easy-to-assess metrics associated with wound size, ischemia, and degree of infection [12].

The +WoundDesk is a mobile solution for professional assessment and documentation of chronic wounds developed by a team of medical doctors and mobile specialists and it can be incorporated into any wound care routine [20].

One disadvantage of these apps is the fact that they can be used for a range of chronic wounds and not used exclusively for the management of DFUs. MyFootCare is a mobile app (Fig. 2A) developed to engage people with DFUs in their self-care away from the clinic [10]. Main features of the app included: (i) a goal image selected by the patient to be exposed on the home screen, (ii) photo capture and visual analytics of the photo to detect the ulcer and calculate its size, (iii) a photo gallery, (iv) wound progress graph, (v) a diary to encourage reflection on self-care and finally (vi) reminder notifications [10].

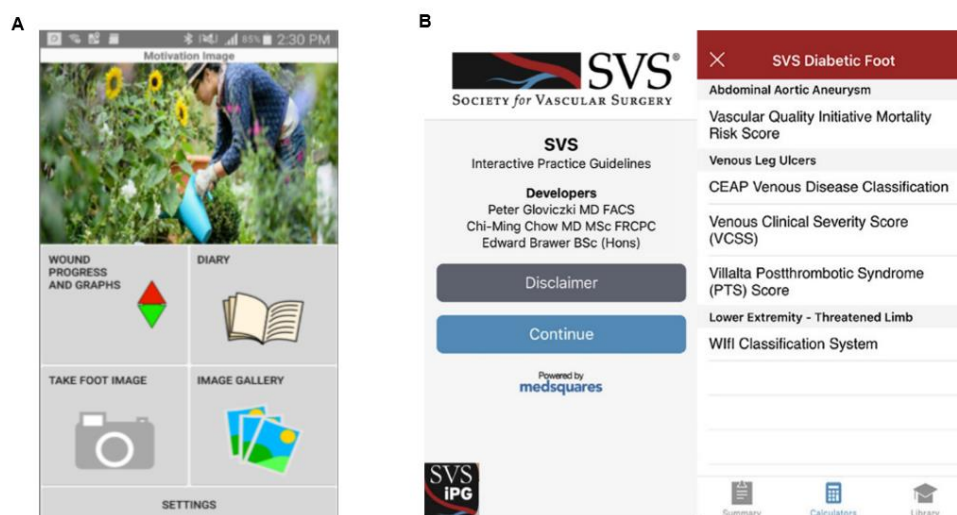


Fig. 2. Mobile apps. **A.** MyFootCare home screen showing a photographic image of the patient's goal at the top and access to all features. Retrieved from [10]. **B.** SVS iPG application, wound classification and calculator to estimate Wlfl score. Adapted from [12].

Although mobile apps offer several advantages in patient care, stand-alone apps have limited clinical efficacy and sustainability and are more likely to fail over time [13]. The requirement for constant input from the patient is also another disadvantage, with some patients describing the apps as additional work, increasing the already significant workload involved in ulcer care and diabetes management [10], [13].

Considering the above-mentioned there is a need for combining the apps with wearable devices and sensors that can project the data automatically [13], [15]. Examples of such technologies are SurroSense Rx from Orpyx Medical Technologies Inc., Calgary, Canada [12], and CORSTRATA (Fig. 3) [21].

SurroSense Rx enables continuous screening plantar pressure through smart insoles and notifies the patient if a sustained plantar pressure beyond a predefined threshold was detected. This technology can be used to assist with the prevention of diabetic foot ulcers [12].

CORSTRATA delivers a comprehensive wound care management program, wound patient consultations and specific services such as (i) wound program assessment, (ii) formulary design, (iii) treatment guidelines assessment, (iv) wound documentation review and (v) education [21]. Wound program development is available for different chronic wounds, including diabetic foot ulcer prevention and management using a smart thermometric mat [21].



Fig. 3. Wearable devices and sensors. **A.** SurroSense Rx (Orpyx) smart insoles to screen sustained plantar pressure. Adapted from [12]. **B.** Corstrata smart thermometric mat – remote temperature monitoring technology. Adapted from [21].

Most studies reviewed reported that telemedicine consultations supplementing outpatient clinic visits increased the frequency of complete healing and the healing rate of DFUs, thus reducing the frequency of lower extremity amputation. Tchero et.al. concluded that telemedicine can be as good as traditional care in achieving ulcer care and healing [17].

Obstacles to the implementation of telemedicine approaches in diabetic foot care include the lack of cost-effectiveness studies and reimbursement strategies. Nevertheless, telehealth and telemedicine applications are proving to assist in self-monitoring of foot status, thus reducing the patient and healthcare burden of diabetic foot disease [11].

Since most of the telemedicine applications reported in the literature involved the interaction between visiting nurses and physicians without the direct involvement of the patients, new approaches to empower patients to actively care for and manage their ulcers are required.

Chapter 3 – Tele-Scar Platform

3.1. System Request

Our workgroup is planning to design a platform to monitor and provide follow-up to patients with diabetic foot ulcers. This new platform is intended to support a patient's self-management of diabetic foot ulcers, to monitor and promote a patient's adherence to self-care tasks and replace some of the face-to-face clinic encounters with virtual communication between the patient and the clinician.

Patients must select a wound care supervisor from our board of certified clinicians to be responsible for their self-care treatment. A wound care management plan is set after a first encounter between the clinician and the patient.

Within the platform, the patients have access to four different features. In one of the features, the patient can insert their glycemic levels and access their old ones in order to have a better understanding of their condition. Since education in diabetes self-management is a fundamental aspect of diabetes care, patients will have access in a second feature, to relevant information from reliable sources such as DGS about diabetes and diabetic foot ulcers (e.g., how to change their dressings daily).

The third feature allows the patient to record the state of his/her diabetic foot ulcers through photos. Self-notes, observations or complaints (e.g., too much drainage, painful wound, etc.) can be uploaded alongside the picture to give a more detailed and personalized description, thus helping the clinician to better understand the condition.

According to the patients' condition, different periodicities by which the photos must be taken and uploaded are recommended by the clinician.

Since patient engagement in the wound care management plan is vital, alerts/notifications will be sent to the patient daily to assure that the plan is being satisfied (e.g., the foot is being assessed, glucose levels are being measured, etc.).

The last feature is the patient-clinician interface to facilitate scheduling videoconference appointments, obtain additional clarification about the care management plan, or request the wound care supervisor to view the data right after it was uploaded.

To have access to all the features provided by the platform the patient must subscribe and pay an annual fee which is automatically renewed unless the patient chooses to cancel the subscription before the renewal date.

Clinicians must be able to access the platform to see which patients they are responsible for and to access the patients' data. The data is presented to the wound care supervisor in an easy to read and analyze manner. The clinician may view the data at specific times (for example,

during a specific scheduled time of the day) or in response to patient requests. This data can be incorporated into the patient electronic medical record (EMR).

Based on the received data the wound care supervisor can monitor the patient's adherence to self-care tasks, scale the lesions according to the Wagner scale, and provide directions on how to care for the ulcer (e.g., change the periodicity of the photos, recommend a different wound dressing change frequency). This feedback can be given weekly or daily, depending on the patients' condition, via messages or in real-time by videoconference through a secure two-way communication system between the mobile app (patient) and wound care supervisor portal (a web-based system designed for the clinicians).

The clinician may also consult with a physician when interventions require clinical supervision, thus maintaining high standards of wound care.

3.2. Analysis Modeling

The analysis modeling of a system answers the questions of *who* will use the system, the *purpose*, and *what* the system will do [16]. During analysis, requirements were gathered and organized, and functional models were created. In this section, it will be presented the system requirements and its functional models.

3.2.1. System Requirements

The envisioned system is intended to improve how diabetic people manage and care for their DFUs by applying technology to change the existing model of care. Moderate changes will be performed to the way monitoring, care, and education are delivered, but the objectives of the first level of care will not be changed. For this reason, it was necessary to gather information regarding the existing care system, its participants, their role and interactions, and identify opportunities for improvement.

Before moving into requirements determination, it was necessary to analyze existing projects and strategies, to develop a deeper understanding of what strategy to adopt.

During the third sprint of the project, our workgroup brainstormed technical solutions and developed a concept for the new system. A list of high-level requirements, regarding the main characteristics the system should have, was developed:

- Reminders for diabetic foot care;
- Photographic follow-up for monitoring and consultation;
- Appointment scheduling;
- Personalized and easy-to-understand wound self-care clinician-oriented plans;
- Secure two-way communication between patients and clinicians (videoconference and text).

This list was expanded and refined during the project analysis to ensure that the needs of the users were met.

The gathered requirements were divided into functional (related to the information and processes the system must contain and perform, respectively – what the system must do) [16] and non-functional (related to the behavioral properties a system must have, such as performance and usability) [16]. The latter was further divided into operational, performance, cultural and political, and security requirements (Table 2.).

Table 2. Non-functional requirements of the Tele-Scar Platform

Requirements	
Operational	The system should operate on any web browser including mobile
Performance	The system must be available 24 hours daily (365 days per year)
	Response time for interactions between the system and its users should be less than five seconds
Security	Access to patient medical information is limited to medical staff only
Cultural and Political	The system must comply with all medical regulatory requirements

The functional requirements were organized into a list containing sixteen requirements.

R₁	allow the patients to subscribe and pay the annual fee
R₂	keep a complete list of all clinicians and their personal information including name, age, gender and professional background
R₃	allow the patients to choose a wound care supervisor from a list of certified clinicians
R₄	keep track of how many patients a clinician is responsible for so that each wound care supervisor is responsible for a limited number of patients
R₅	allow patients to insert their glycemic levels, and keep a record of all their past glycemic measurements
R₆	allow patients to access reliable information about diabetes and diabetic foot ulcers
R₇	allow patients to upload photos and observations, self-notes or complaints of their diabetic foot ulcers
R₈	monitor patient's engagement in the wound care management plan and send alerts/notifications
R₉	allow patients to contact with the wound care supervisor through videoconference or text (chat messages)
R₁₀	allow the wound care supervisors to see which patient's they are responsible for, as well as their data
R₁₁	allow the clinician to set a wound care management plan suitable for each patient
R₁₂	allow the wound care supervisor to give feedback via text or videoconference
R₁₃	renew the patient's annual subscription and allow the patient to cancel it
R₁₄	cooperate with the patient's bank to allow payment
R₁₅	keep a record of all the patients and wound care supervisors and their past actions
R₁₆	allow communication between wound care supervisor and physician

3.2.2. Functional Modeling

After the requirements were gathered and organized into a list, our project team developed three models to describe the functionality of the system: use case diagram and descriptions, and activity diagrams. The use case model describes the system's functional requirements in terms of use cases [16]. For each use case, a use case description was created. The activity diagrams were created to support the logical modeling of the system processes and workflows [16].

The process of modeling and reviewing was performed over four sprints (sprints three to seven). During this period the models were verified and validated by ensuring that all three models (use case diagram, activity diagrams, and use case descriptions) were consistent with one another.

A. Use Case Diagram

To illustrate the main functions of the system and the different users that will interact with it, a use case diagram was developed.

The uses cases were carefully reviewed to check if was necessary to further split some of them into multiple use cases (include and extend conditions) or merge some of them into a single use case to avoid exceeding the maximum advisable number of fifteen use cases (base plus include or extend). Special care was also taken to avoid functional composition.

Twelve base use cases plus one extension and four actors were identified, in accordance with the initial system request and the requirements of the system (Fig.4). For the sake of clarity, an "extend" relationship was created for the base use case "Contact with the Wound Care Supervisor". The extended use case "Contact via Videoconference" represents a functionality that is available if required and the user can opt to use over the norm.

The actors' role (what or whom the actor represents) in the system and their goals (what interest the actor has in the system) or actions (why the actor is needed) were described.

Patient: A Patient is a person with diabetic foot complications who is registered at the Tele-Scar platform and seeks medical monitorization and counseling.

Wound Care Supervisor: A Wound Care Supervisor is a qualified clinician (diabetes nurse) who has the authorization to access the patients' list and data, establish a wound care management plan, monitor the patient's condition, and give feedback on how to care the diabetic foot ulcer.

Physician: A Physician is a qualified podiatrist responsible for giving counseling in wound care treatment.

Bank: The Bank is a financial institution responsible for verifying the patients' credit card information and bank account balance and authorize payments.

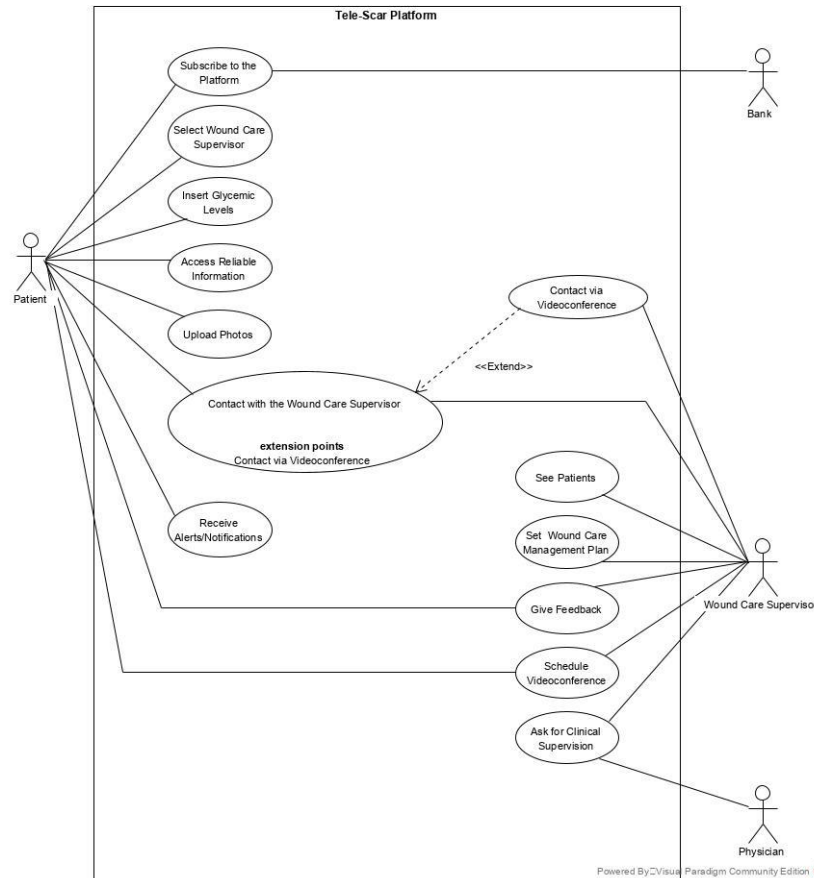


Fig. 4. Tele-Scar Use Case Diagram.

B. High Level and Expanded Use Case Descriptions

The use case descriptions are a narrative document that describes the required functionality of the use cases. For project development is often useful to have two distinct types of use case description: high level (short general description of what happens) and expanded (more detailed and structured, include the basic and alternative course of events, pre- and postconditions) [22].

A high-level description was written for each use case, except for the base use case “Contact with the Wound Care Supervisor” and the extended use case “Contact via Videoconference, in which only one high-level description was written for both use cases. The expanded descriptions were written for every use case.

The high-level descriptions for each use case are represented in Appendix II – High-Level Description of the Tele-Scar Use Cases. The expanded descriptions are present in Appendix III to XV.

C. Activity Diagrams

An activity diagram describing the underlying activities (basic and alternative course of events) that support the use cases was created. Unlike the use case descriptions, activity diagrams were only created to describe a determined set of use cases, with a complex flow of events, i.e., with more than three alternative courses of events.

Taken into consideration the abovementioned criteria, five activity diagrams were created for the: “Subscribe to the Platform”, “Select Wound Care Supervisor”, “Schedule Videoconference”, “Insert Glycemic Levels” and “Upload Photos” use cases.

The activity diagrams regarding those five use cases are represented in the Appendixes XVI to XX.

3.3. Design Modeling

Whereas the analysis modeling has been concentrated on the functional requirements of the system, in the design modeling it will be incorporated the non-functional requirements, focusing on how the platform will operate [16]. In this section, it will be presented the work developed through the sprints five to seven: the package diagram of the system and the users (Patient and Wound Care Supervisor) interface prototypes.

3.3.1. Package Diagram

To make the diagrams easier to read and keep the models at a reasonable level of complexity, a use case package diagram groups use cases together into packages (i.e., logical groups of use cases) [16].

The platform’s use cases were grouped into five packages as depicted in Figure 5. Separate packages were created for each actor and its use cases, however since some packages had too many uses cases, an additional package was created.

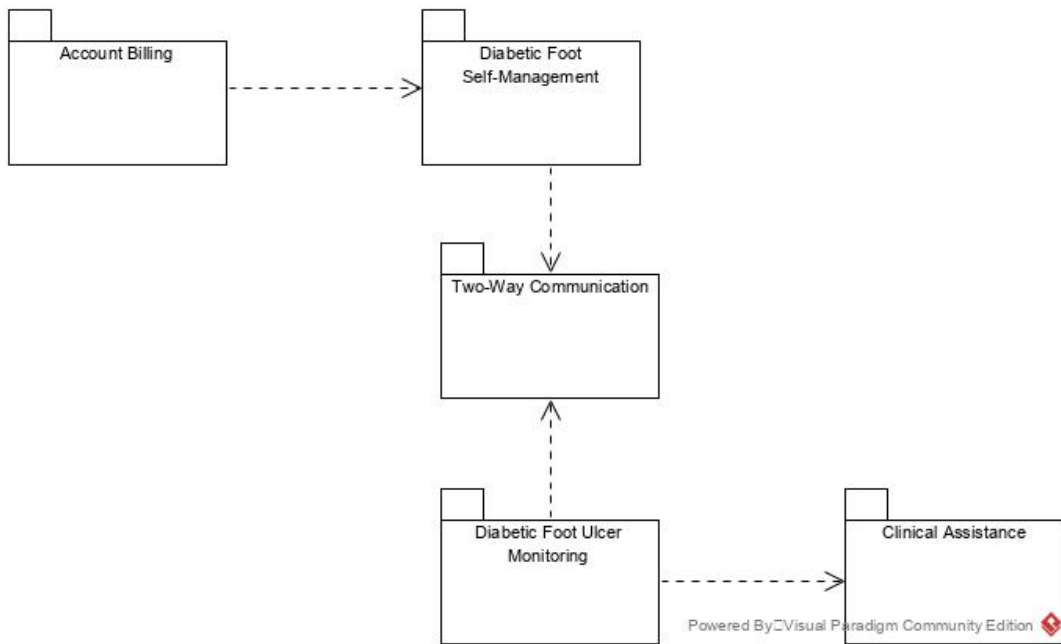


Fig. 5. Tele-Scar Package Diagram.

The representation of the use cases associated with each package is present in Appendix XXI – Use Case Package Diagram.

3.3.2. Interface Design Prototyping

The system that we have designed consists of the Tele-Scar app, the wound care supervisor portal, and two-way communication between the two (Fig. 6).

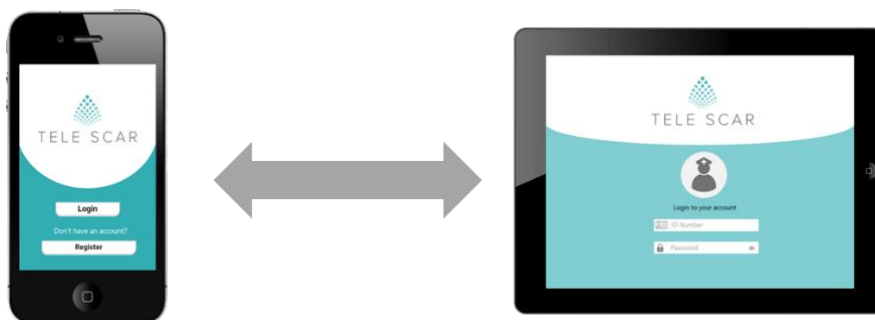


Fig. 6. Tele-Scar Platform Overview.

To design the patient's mobile interface and the clinician portal, it was performed a thorough study of the use cases and diagrams created to ensure that the look and feel of those interfaces would support the use cases on which they were based. The user interface prototypes of both platforms were done using a free UI mockup design interface, the Pencil Project.

This software has the distinct advantage of allowing the development of executable prototypes of the user interface. The different parts of the user interface are linked together so that as the user clicks on buttons, the requested part of the system appears, thus showing exactly what the screens will look like [16].

In the Tele-Scar app's main screen, are present all the features the patient has access to, including messages and notifications he/she may have received (Fig. 7A).

The "wound care management" feature allows the patient to report the diabetic ulcer and send the information to the clinician portal (Fig.7B). The photos and descriptions are recorded and organized by date. The former, the "glycemic levels" and "wound care supervisor" features are only accessible once the patient has chosen a wound care supervisor (Fig.7C). However, the patient can still search for reliable information even if he/she has not chosen a wound care supervisor to be responsible for his/her plan.

The "wound care supervisor" feature allows the patient to see his/her clinician's personal information, schedules for videoconferences, and send messages (Fig.7D). The purpose of the messaging is to allow patients and wound care supervisors to discuss ulcer evolution and how to conduct self-care routines.



Fig. 7. Tele-Scar Mobile app. **A.** Patient's mobile app home screen with all the features and notifications. **B.** Wound Care Management Feature. The patient can add descriptions to the photos of his/her diabetic foot. **C.** If the patient is not assigned into one of the nurses' list of patients an error message is displayed. **D.** Wound Care Supervisor Feature. The patient may contact his/her clinician through messages or videoconference.

The web-based clinician portal stores all the data sent from the patient mobile app including the photos and descriptions, the glycemic values, and messages from the patient. On the portal's home screen is represented the clinician's schedule and reminders, the features he/she can access such as documents and settings, and lastly the list of patients he/she is responsible for (Fig. 8A).

Once the wound care supervisor chooses a patient from the list, he/she will have access to all that patient's data. The clinician can give feedback according to the patient's recent data, although he/she may also access to a series of previous images to easily track progress by comparing the diabetic foot ulcer conditions over time (Fig. 8B).

The feedback is given using the secure communication feature, which in this case, it will work in a similar way to text messaging (Fig. 8C). Within the portal, the wound care supervisors will also be able to make changes to the management plan or schedule videoconferences with the patients (Fig. 8D).

By using the portal, clinicians can actively support a patient to successfully self-manage his/her condition.



Fig. 8. Wound Care Supervisor Portal. **A.** In the main screen the clinicians have access to his/her schedule and list of patients. **B.** The wound care supervisor can see the data of the patients he/she is responsible for. **C.** According to the patient's data, the nurse can give advices on how to care for the ulcer and make any comments regarding the plan. **D.** The nurse can make changes to the patient wound care management plan according to the patient's current situation.

Chapter 4 – Conclusions and Future Work

Mobile apps are being gradually incorporated into the care of patients with diabetes – digital therapy. The Tele-Scar platform presented in this paper is intended to help a patient acquire the knowledge and skills required to successfully self-manage his/her condition and improve outcomes. The system has a unique feature of communication between the patient and the wound care supervisor.

Further improvements to the design of the Tele-Scar platform could be the addition of a voice assistance mechanism as employed in [] to help patients living on their own since taking photos of the plantar side of the foot can be a quite challenging task if we consider people without assistance.

Nevertheless, the designed system has promising features that could assist and empower the individuals in better managing their condition.

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Appendix I – Sprint and Product Backlog

Product Backlog	Sprint Backlog								
	Sprint # 1	Sprint # 2	Sprint # 3	Sprint # 4	Sprint # 5	Sprint # 6	Sprint # 7	Sprint # 8	Sprint # 9
<i>State of the Art</i>	State of the art	Initial System Requests	List of Requirements	Activity Diagram	Package Diagram	Package Diagram	Mockup	Report	Report
<i>Initial System Requests</i>			Use Case Diagram	Use Case Diagram	Activity Diagram	Mockup	Activity Diagram		
<i>List of Requirements</i>			Expanded and High-Level Description	Expanded and High-Level Description	Mockup	Use Case Diagram	Report		
<i>Use Case Diagram</i>					Video	Expanded and High-Level Description			
<i>Expanded and High-Level Description</i>					Presentation				
<i>Activity Diagram</i>					Use Case Diagram				
<i>Package Diagram</i>					Expanded and High-Level Description				
<i>Mockup</i>									
<i>Video</i>									
<i>Presentation</i>									
<i>Report</i>									

Appendix II – High-Level Description of the Tele-Scar Use Cases

Use Case: Subscribe to the Platform

Actors: Patient and Bank

Goal: Subscribe and pay the annual fee

Description:

Once a patient registers for an account and begins his/her subscription, he/she will be charged on a yearly basis, starting from the sign-up date. The patient inserts his/her credit card information, the information is sent to the bank to allow the payment. Patients must also insert their personal information. The subscription and annual charge are automatically renewed unless the patient chooses to cancel it before the renewal date.

Use Case: Select Wound Care Supervisor

Actors: Patient

Goal: Choose a clinician

Description:

Patients must choose from a list of available certified clinicians, the wound care supervisor that will be responsible for his/her wound care management plan.

Use Case: Insert Glycemic Levels

Actors: Patient

Goal: Insert the measured glycemic levels

Description:

Patients can insert their glycemic levels as well as indicate at which time of the day those measurements correspond to (before breakfast, before lunch, etc.). Patients can also access a record with their previous glycemic measurements in order to have a better follow-up of their condition.

Use Case: Access Reliable Information

Actors: Patient

Goal: Access reliable information about diabetes and diabetic foot ulcers

Description:

Patients have access to reliable and relevant information about diabetes and diabetic foot ulcers (e.g., how to change their wound dressings).

Use Case: Upload Photos

Actors: Patient

Goal: Upload photos of the diabetic foot ulcers

Description:

Patients record the state of his/her diabetic foot ulcers through photos which are then uploaded into the platform. Patients may also upload alongside with the photos self-notes, observations or complaints, to give a more detailed and personalized description of the foot ulcer.

Use Case: Contact the Wound Care Supervisor

Actors: Patient and Wound Care Supervisor

Goal: Contact with the clinician

Description:

Patients can contact the wound care supervisor responsible for his/her wound care management plan through chat messages or videoconference (only when necessary) in order to obtain additional clarification about the plan or request the clinician to view the data uploaded.

Use Case: See Patients

Actors: Wound Care Supervisor

Goal: See the patients he/she is responsible for, as well as their data

Description:

Wound Care Supervisors can access a list of the patients they will be responsible for, and see the data uploaded in the system by those patients.

Use Case: Set Wound Care Management Plan

Actors: Wound Care Supervisor

Goal: Access the data uploaded by the patient in the platform and develop a wound care management plan

Description:

Wound Care Supervisors have access to the data (glycemic levels, diabetic foot pictures, and observations) uploaded by patients in order to develop a management plan suitable for each patient, as well as follow his/her evolution.

Use Case: Give Feedback

Actors: Wound Care Supervisor and Patient

Goal: Provide feedback about the wound management plan

Description:

Based on the patient's data, clinicians can formulate clinical recommendations on how to care for the diabetic foot ulcer, such as change the periodicity of the photos or recommend a different wound dressing change frequency. This feedback can be given daily or weekly, according to the patient's condition.

Use Case: Schedule Videoconference

Actors: Wound Care supervisor and Patient

Goal: Contact with the patient

Description:

Whenever the clinician considers necessary a videoconference with the patient may be scheduled. Videoconferences may be used to give feedback or information to the patient, that could not be given via text. Since it allows a more dynamic interaction with the patient, wound care supervisors can obtain a better perspective/visibility of the diabetic foot ulcer (helpful in cases where the photos were not clear enough), and can also ask the patients questions they may find relevant.

Use Case: Ask for Clinical Supervision

Actors: Wound Care Supervisor and Physician

Goal: Receive clinical advice

Description:

The clinician may consult a qualified physician whenever an intervention requires clinical supervision.

Use Case: Receive alerts/notifications

Actors: Patient

Goal: Receive alerts/notifications daily

Description:

Since patient engagement in the wound care management plan is vital, the platform will send alerts/notifications to the patient daily to assure that the plan is being satisfied (e.g., foot is being assessed, glucose levels are being measured, etc.).

Appendix III – Expanded Description: Subscribe to the Platform

Use Case: Subscribe to the Platform

Actors: Patient and Bank

Goal: Subscribe and pay the annual fee

Overview:

Once a patient registers for an account and begins his/her subscription, he/she will be charged on a yearly basis, starting from the sign-up date. The patient inserts his/her credit card information, the information is sent to the bank to allow the payment. Patients must also insert their personal information. The subscription and annual fee are automatically renewed unless the patient chooses to cancel it before the renewal date.

Cross-reference:

R1, R13, R14

Basic course of events:

1. Register for an account
This use case starts when a patient accesses the Tele-Scar platform and registers for an account. *The system asks for an email account and password.* The patient provides an email account and a password. *The system validates the email and password.*
2. Select “Subscribe”
The system displays the subscription plan to the patient. The patient selects “Subscribe”.
3. Enter credit card information
The patient enters his/her credit card information (card number, the cardholder name, the expiration date, and the CVV).
4. Select “Pay Subscription”
The patient purchases the subscription plan. *The system sends the credit card information to the bank.* The bank validates the credit card information and approves the transaction.
5. Enter personal information
The system asks the patient to enter his/her personal information (e.g., name, age, gender, medication, etc.) The patient enters his/her personal information.
6. Submit Personal Information
The patient submits his/her personal information. *The system verifies that the information is complete.*
7. Accept Personal Information
The system displays the patient’s personal information. The patient accepts the personal information.
The use case ends.

Alternative courses:

Step 1 If the email account is not valid, the system displays an error message. The use case ends.

Step 4 If the credit card information is incorrect or if there is an insufficient balance on the account, the bank declines the transaction, the access to the Tele-Scar platform is denied and the system displays an error message. The use case ends.

Step 6 If the patient's personal information is incomplete, the system displays a message indicating that the personal information is incomplete. The use case continues at "Enter personal Information" (*step 5*).

Quit The system allows the patient to quit at any time during the use case. The patient may choose to save the data already inserted. Unsaved data are not recorded in the system. The use case ends.

Preconditions: The patient has an internet connection.

The patient has a valid email account, credit card, and enough balance on his/her bank account.

Postconditions: At the end of the use case either the patient has registered for an account and subscribed to the platform or registration/subscription was unsuccessful and the access to the Tele-Scar platform was denied.

Appendix IV – Expanded Description: Select Wound Care Supervisor

Use Case: Select Wound Care Supervisor

Actors: Patient

Goal: Choose a clinician

Overview:

Patients must choose from a list of available certified clinicians, the wound care supervisor that will be responsible for his/her wound care management plan.

Cross-reference:

R2, R3, R4, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Wound Care Supervisor”
The system displays the functions available to the patient. The patient selects “Wound Care Supervisor”.
3. Wound Care Supervisor list
The system displays a list of available certified clinicians and displays the list to the patient. The patient can search the list by name or professional background.
4. Select Wound Care Supervisor
The patient selects the wound care supervisor that will be responsible for his/her wound care management plan from the list of available wound care supervisors. *The system acknowledges the selection.*
5. Submit selection
The patient submits the choice. *The system verifies that the chosen clinician has not yet reached his/her maximum patient limit. The system registers the patient in the selected clinician’s patient list.*
6. Accept chosen Wound Care Supervisor
The patient accepts the chosen Wound Care Supervisor.
The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to get a list of available certified clinicians an error message is displayed. The patient acknowledges the error message. The use case ends.

Step 5 If the wound care supervisor has already reached his/her maximum patient limit, the system will not register the patient in the clinician’s patient list. The system displays a message

indicating that the patient must choose another clinician. The use case continues at “Select Wound Care Supervisor” (*step 4*).

Quit The system allows the patient to quit at any time during the use case. The patient may choose to save the wound care supervisor selection. If the patient chooses to save his/her selection the system saves it until the maximum patient limit is reached. Unsubmitted selections will not be assigned the patient to a wound care supervisor. The use case ends.

Preconditions: Patient has an internet connection.
The patient is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the patient has been assigned to the chosen wound care supervisor or the wound care supervisor selection was unsuccessful, and the patient does not have a clinician responsible for his/her wound care management plan.

Appendix V – Expanded Description: Insert Glycemic Levels

Use Case: Insert Glycemic Levels

Actors: Patient

Goal: Insert the measured glycemic levels

Overview:

Patients can insert their glycemic levels as well as indicate at which time of the day those measurements correspond to (before breakfast, before lunch, etc.). Patients can also access a record with their previous glycemic measurements to have a better follow-up of their condition.

Cross-reference:

R5, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Glycemic Levels”
The system displays the functions available to the patient. The patient selects “Glycemic Levels”.
3. Select “Insert Glycemic Levels”
The patient selects “Insert Glycemic Levels”. *The system acknowledges the selection.*
4. Insert Glycemic Levels
The patient inserts his/her glycemic levels and indicates at which time of the day those measurements correspond to (before breakfast, before lunch, etc.).
5. Submit Measurements
The patient submits the glycemic values. *The system validates and records the values and dates.*
6. See Glycemic Levels
The system retrieves and displays a record with the previously measured glycemic levels. The patient can view the data in a chart or table according to his/her preference. The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 5 If the system is unable to record the patient's glycemic levels and date, an error message is displayed. The use case ends.

Step 5 If the glycemic values are not valid (inserted values are outside of the value range), the system displays an error message. The use case continues at “Insert Glycemic Levels” (*step 4*).

Step 6 If the system is unable to retrieve the previous glycemic measurements, an error message is displayed. The use case ends.

Quit The system allows the patient to quit at any time during the use case. The patient may choose to submit some of the glycemic values already inserted. The values that are not submitted are not recorded in the system. The use case ends.

Preconditions: Patient has an internet connection.

The patient is registered and has access to the Tele-Scar platform. The patient has already measured his/her glycemic levels.

Postconditions: At the end of the use case either the patient has submitted his/her glycemic levels or insert glycemic levels were unsuccessful and no alterations have been made to patient glycemic data.

Appendix VI – Expanded Description: Access Reliable Information

Use Case: Access Reliable Information

Actors: Patient

Goal: Access reliable information about diabetes and diabetic foot ulcers

Overview:

Patients have access to reliable and relevant information about diabetes and diabetic foot ulcers (e.g., how to change their wound dressings).

Cross-reference:

R6, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Access Reliable Information”
The system displays the functions available to the patient. The patient selects “Access Reliable Information”.
3. Enter the search topic
The patient enters the topic (subject) he/she wants to search for. *The system retrieves links related to the topic of search from trusted sources, such as the DGS.*
4. Select the link of interest
The patient selects the link he/she found more suitable. *The system sends the patient to the page associated with the chosen link.*
The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system could not find any information related to the topic of search, a message stating that the search was unsuccessful is displayed. The use case ends.

Step 4 If the system is unable to send the patient to a page associated with the chosen link, an error message is displayed. The use case ends.

Quit The system allows the patient to quit at any time during the use case. All the ongoing search is stopped. The use case ends.

Preconditions: Patient has an internet connection.

The patient is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the patient has access to reliable information concerning what he/she has searched for or the search for reliable information was unsuccessful and no information was presented to the patient.

Appendix VII – Expanded Description: Upload Photos

Use Case: Upload Photos

Actors: Patient

Goal: Upload photos of the diabetic foot ulcers

Overview:

Patients record the state of his/her diabetic foot ulcers through photos which are then uploaded into the platform. Patients may also upload alongside the photos self-notes, observations or complaints, to give a more detailed and personalized description of the foot ulcer.

Cross-reference:

R7, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Foot Ulcer Management”
The system displays the functions available to the patient. The patient selects “Foot Ulcer Management”.
3. Select “Take Photo”
The patient selects “Photo”. *The system accesses the camera of the patient’s mobile device.*
4. Take Photo
The patient takes a photo of his/her foot.
5. Add a description
When the patient chooses to save the photo, the system asks the patient to add a description with complaints or observations that he/she may find relevant. The patient may or may not add a description.
6. Submit photo
The patient submits the photo. *The system records the photo and its description (when applicable).*
7. See Foot Ulcers’ Photos
The system retrieves a record with the patient’s foot ulcers’ photos organized by date.
The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to access the camera of the patient’s mobile device, an error message is displayed. The use case ends.

Step 4 If the patient considers that the picture does not have a good quality, the patient can choose to take another photo. The use case continues at "Take Photo" (*step 4*).

Step 6 If the system is unable to record the patient's foot ulcer photo, an error message is displayed. The use case ends.

Quit The system allows the patient to quit at any time during the use case. The photos that are not submitted are not recorded in the system. The use case ends.

Preconditions: Patient has an internet connection.

The patient is registered and has access to the Tele-Scar platform. The patient's mobile device has a functioning camera.

Postconditions: At the end of the use case either the patient has taken and submitted a photo of his/her foot or, the foot ulcer registry was unsuccessful, and no photo was submitted into the system.

Appendix VIII – Expanded Description: Contact with the Wound Care Supervisor

Use Case: Contact with the Wound Care Supervisor

Actors: Patient and Wound Care Supervisor

Goal: Contact with the clinician

Overview:

Patients can contact the wound care supervisor responsible for his/her wound care management plan through chat messages in order to obtain additional clarification about the plan or request the clinician to view the data uploaded.

Cross-reference:

R2, R3, R4, R9, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Wound Care Supervisor”
The system displays the functions available to the patient. The patient selects “Wound Care Supervisor”. *The system retrieves the patient’s clinician’s personal information and displays the available means of contact to the patient.*
3. Select “Chat Messages”
The patient chooses to contact the health care professional through chat messages. *The system acknowledges the patient’s choice.*
4. Write message
The patient writes the message he/she wants to send to the wound care supervisor.
5. Submit and send message
The patient indicates that the message is complete. *The system verifies the message content and that there are no spelling errors. The message is sent to the clinician.*
The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 5 If the system determines that the message has spelling errors a message is displayed asking the patient to correct the message content. The use case continues at “Write message” (*step 4*).

Step 5 If the system is unable to send the message to the wound care supervisor, an error message is displayed. The use case ends.

Quit The system allows the patient to quit at any time during the use case. The patient may choose to save the message. The messages that are not saved are not recorded in the system. The use case ends.

Preconditions: Patient has an internet connection.

The patient is registered and has access to the Tele-Scar platform. The patient is assigned to one wound care supervisor.

Postconditions: At the end of the use case either the patient has consulted with the clinician through messages or the communication was unsuccessful, and no contact was established.

Appendix IX – Expanded Description: Contact via Videoconference

Use Case: Contact via Videoconference

Actors: Patient and Wound Care Supervisor

Goal: Contact with the clinician

Overview:

Patients have the option to contact with the wound care supervisor responsible for his/her wound care management plan through videoconference (only when necessary) in order to obtain additional clarification about the plan.

Cross-reference:

R2, R3, R4, R9, R15

Basic course of events:

1. Sign in
This use case starts when a patient accesses the Tele-Scar platform. *The system asks for identification information.* The patient enters the email account and password. *The system validates the email and password.*
2. Select “Wound Care Supervisor”
The system displays the functions available to the patient. The patient selects “Wound Care Supervisor”. *The system retrieves the patient’s clinician’s personal information and displays the available means of contact to the patient.*
3. Select “Videoconference”
The patient chooses to contact the wound care supervisor through videoconference. *The system acknowledges the patient’s choice.*
4. Select “Schedule Videoconference”
The system retrieves a list of possible schedules (days and hours). The patient selects a schedule.
5. Submit the chosen schedule
The patient saves the chosen schedule. *The system verifies that there are no schedule conflicts, saves the chosen date and hour, and sends a message to inform the clinician of the chosen videoconference schedule.* The use case ends.

Alternative courses:

Step 1 If the system determines that the patient's email account and/or password are not valid, an error message is displayed. The use case ends.

Step 5 If the wound care supervisor is no longer available at the scheduled day and hour the system displays a message indicating that the patient must choose another schedule. The use case continues at “Select Schedule Videoconference” (*step 4*)

Step 5 If the system is unable to send the message informing the wound care supervisor, an error message is displayed. The use case ends.

Quit The system allows the patient to quit at any time during the use case. The patient may choose to save the chosen schedule. Schedules that are not saved will appear as available to the other patients. The use case ends.

Preconditions: Patient has an internet connection.

The patient is registered and has access to the Tele-Scar platform. The patient is assigned to one wound care supervisor.

Postconditions: At the end of the use case either the patient has consulted with the clinician in real-time (videoconference), or the scheduling was unsuccessful, and no contact was established.

Appendix X – Expanded Description: See Patients

Use Case: See Patients

Actors: Wound Care Supervisor

Goal: See the patients he/she is responsible for

Overview:

Wound Care Supervisors can access a list of the patients they will be responsible for, and see the data uploaded in the system by those patients.

Cross-reference:

R2, R3, R4, R10, R15

Basic course of events:

1. Sign in
This use case starts when a wound care supervisor accesses the Tele-Scar platform. *The system asks for identification information.* The clinician enters his/her ID and password. *The system validates the ID and password.*
2. Select “Patients”
The system displays the functions available to the wound care supervisor. The wound care supervisor selects “Patients”.
3. Obtain Patients list
The system retrieves a list of patients the clinician is responsible for and displays it to the wound care supervisor. The clinician can search the list by name.
4. Select patient
The clinician selects a patient from the list of patients. *The system acknowledges the selection.*
5. See patient data
The system retrieves the data uploaded by the patient. The system displays the data organized by content: glycemic values, foot ulcer photos and their descriptions, chat messages, and scheduled videoconferences. The wound care supervisor sees the patient’s data.
The use case ends.

Alternative courses:

Step 1 If the system determines that the wound care supervisor ID and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to get a list of patients an error message is displayed. The clinician acknowledges the error message. The use case ends.

Step 5 If the system is unable to retrieve the patient’s data an error message is displayed. The use case ends.

Quit The system allows the wound care supervisor to quit at any time during the use case. The ongoing actions (get list/data and display list/data) are stopped. The use case ends.

Preconditions: Wound care supervisor has an internet connection.

The wound care supervisor is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the wound care supervisor was able to see the list of patients he/she is responsible for, as well as access their data or the search was unsuccessful, and no list and data were displayed.

Appendix XI – Expanded Description: Set Wound Care Management Plan

Use Case: Set Wound Care Management Plan

Actors: Wound Care Supervisor

Goal: Access the data uploaded by the patient in the platform and develop a wound care management plan

Overview:

Wound Care Supervisors have access to the data (glycemic levels, diabetic foot pictures, and observations) uploaded by patients in order to develop a management plan suitable for each patient, as well as follow his/her evolution.

Cross-reference:

R2, R3, R4, R10, R11, R15

Basic course of events:

1. Sign in
This use case starts when a wound care supervisor accesses the Tele-Scar platform. *The system asks for identification information.* The clinician enters his/her ID and password. *The system validates the ID and password.*
2. Select “Patients”
The system displays the functions available to the wound care supervisor. The wound care supervisor selects “Patients”.
3. Obtain Patients list
The system retrieves the list of patients the clinician is responsible for and displays it to the wound care supervisor. The clinician can search the list by name.
4. Select patient
The clinician selects a patient from the list of patients. *The system retrieves and displays the chosen patient’s personal data to the wound care supervisor.*
5. Set Wound Care Management Plan
The wound care supervisor sets a wound care management plan suitable for the patient according to his/her data.
6. Submit Wound Management Plan
The wound care supervisor submits the plan. *The system records the management plan and sends it to the patient.*
The use case ends.

Alternative courses:

Step 1 If the system determines that the wound care supervisor ID and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to get a list of patients an error message is displayed. The clinician acknowledges the error message. The use case ends.

Step 6 If the system is unable to send the wound care management plan to the patient, an error message is displayed. The use case ends.

Quit The system allows the wound care supervisor to quit at any time during the use case. The ongoing actions are stopped. The use case ends.

Preconditions: Wound care supervisor has an internet connection.
The wound care supervisor is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the clinician was able to develop a wound care management plan and send it to the patient or the management plan development was unsuccessful, and no plan was created.

Appendix XII – Expanded Description: Give Feedback

Use Case: Give Feedback

Actors: Wound Care Supervisor and Patient

Goal: Provide feedback about the wound management plan

Overview:

Based on the patient's data, clinicians can formulate clinical recommendations on how to care for the diabetic foot ulcer, such as change the periodicity of the photos or recommend a different wound dressing change frequency. This feedback can be given daily or weekly, according to the patient's condition.

Cross-reference:

R2, R3, R4, R10, R12, R15

Basic course of events:

1. Sign in
This use case starts when a wound care supervisor accesses the Tele-Scar platform. *The system asks for identification information.* The clinician enters his/her ID and password. *The system validates the ID and password.*
2. Select "Patients"
The system displays the functions available to the wound care supervisor. The wound care supervisor selects "Patients".
3. Obtain Patients list
The system retrieves the list of patients the clinician is responsible for and displays it to the wound care supervisor. The clinician can search the list by name.
4. Select patient
The clinician selects a patient from the list of patients. *The system retrieves and displays the chosen patient's personal data to the wound care supervisor.*
5. Select "Feedback"
Based on the data, the wound care supervisor writes clinical recommendations such as change the periodicity of the photos or a different wound dressing change frequency.
6. Submit Feedback
The wound care supervisor submits the feedback. *The system records the feedback and sends it to the patient.*
The use case ends.

Alternative courses:

Step 1 If the system determines that the wound care supervisor ID and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to get a list of patients an error message is displayed. The clinician acknowledges the error message. The use case ends.

Step 6 If the system is unable to send the feedback to the patient, an error message is displayed. The use case ends.

Quit The system allows the wound care supervisor to quit at any time during the use case. The ongoing actions are stopped. The use case ends.

Preconditions: Wound care supervisor has an internet connection.
The wound care supervisor is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the clinician was able to give feedback to the patient or the give feedback was unsuccessful, and no feedback was sent to the patient.

Appendix XIII – Expanded Description: Schedule Videoconference

Use Case: Schedule Videoconference

Actors: Wound Care Supervisor and Patient

Goal: Contact with the Patient

Overview:

Whenever the clinician considers necessary a videoconference with the patient may be scheduled. Videoconferences may be used to give feedback or information to the patient, that could not be given via text. Since it allows a more dynamic interaction with the patient, wound care supervisors can obtain a better perspective/visibility of the diabetic foot ulcer (helpful in cases where the photos were not clear enough), and can also ask the patients questions they may find relevant.

Cross-reference:

R2, R3, R4, R10, R12, R15

Basic course of events:

1. Sign in
This use case starts when a wound care supervisor accesses the Tele-Scar platform. *The system asks for identification information.* The clinician enters his/her ID and password. *The system validates the ID and password.*
2. Select “Patients”
The system displays the functions available to the wound care supervisor. The wound care supervisor selects “Patients”.
3. Obtain Patients list
The system retrieves the list of patients the clinician is responsible for and displays it to the wound care supervisor. The clinician can search the list by name.
4. Select patient
The clinician selects a patient from the list of patients. *The system acknowledges the selection.*
5. Select “Videoconference”
The wound care supervisor chooses to contact with the patient through videoconference. *The system retrieves a list of possible schedules (days and hours).* The wound care supervisor selects a day and hour to contact with the patient.
6. Submit the chosen schedule
The wound care supervisor saves the chosen schedule. *The system verifies that there are no schedule conflicts, saves the chosen date and hour, and sends a message to inform the patient of the chosen videoconference schedule.* The use case ends.

Alternative courses:

Step 1 If the system determines that the wound care supervisor ID and/or password are not valid, an error message is displayed. The use case ends.

Step 3 If the system is unable to get a list of patients an error message is displayed. The clinician acknowledges the error message. The use case ends.

Step 6 If the system is unable to send the message informing the patient, an error message is displayed. The use case ends.

Step 6 If the patient is not available at the scheduled day and hour the system displays a message indicating that the clinician must choose another schedule. The use case continues at "Select Schedule Videoconference" (*step 6*).

Quit The system allows the wound care supervisor to quit at any time during the use case. Schedules that are not saved will appear as available. The use case ends.

Preconditions: Wound care supervisor has an internet connection.
The wound care supervisor is registered and has access to the Tele-Scar platform.

Postconditions: At the end of the use case either the wound care supervisor was able to schedule an appointment with the patient, or the scheduling was unsuccessful, and no appointment took place.

Appendix XIV – Expanded Description: Ask for Clinical Supervision

Use Case: Ask for Clinical Supervision

Actors: Wound Care Supervisor and Physician

Goal: Receive clinical advice

Overview:

The clinician may consult a qualified physician whenever an intervention requires clinical supervision, especially in cases where patients' diabetic foot ulcer became worse and may require medical treatment or prescriptions (e.g., custom-molded shoes/orthotics). The direct feedback from a specialist can also help to increase the wound care supervisor's knowledge and skills in treating diabetic ulcers.

Cross-reference:

R15, R16

Appendix XV – Expanded Description: Receive alerts/notifications

Use Case: Receive alerts/notifications

Actors: Patient

Goal: Send alerts/notifications to the patient daily

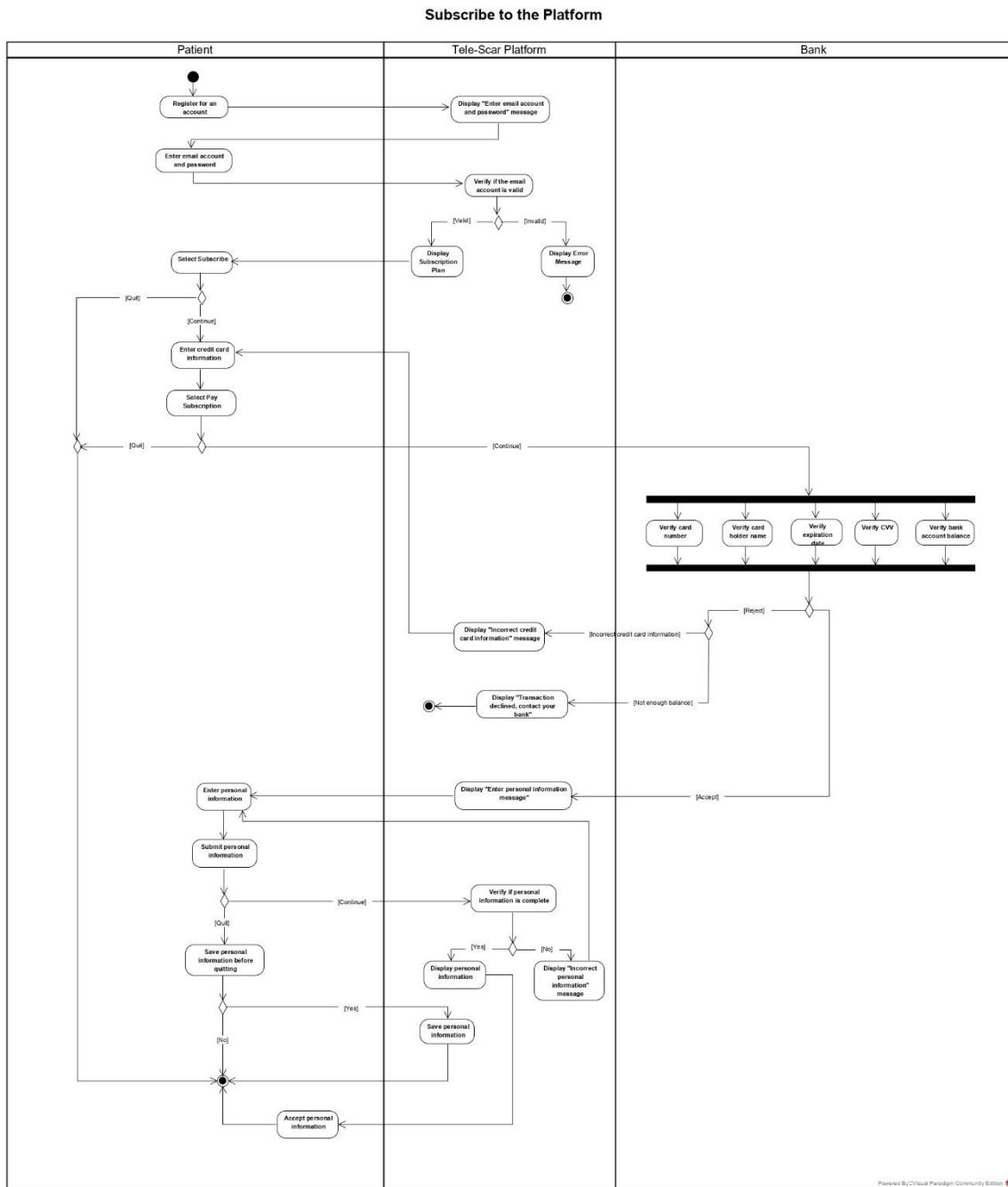
Overview:

Since patient engagement in the wound care management plan is vital, the platform will send alerts/notifications to the patient daily at scheduled times to assure that the plan is being satisfied (e.g., the foot is being assessed, glucose levels are being measured, etc.).

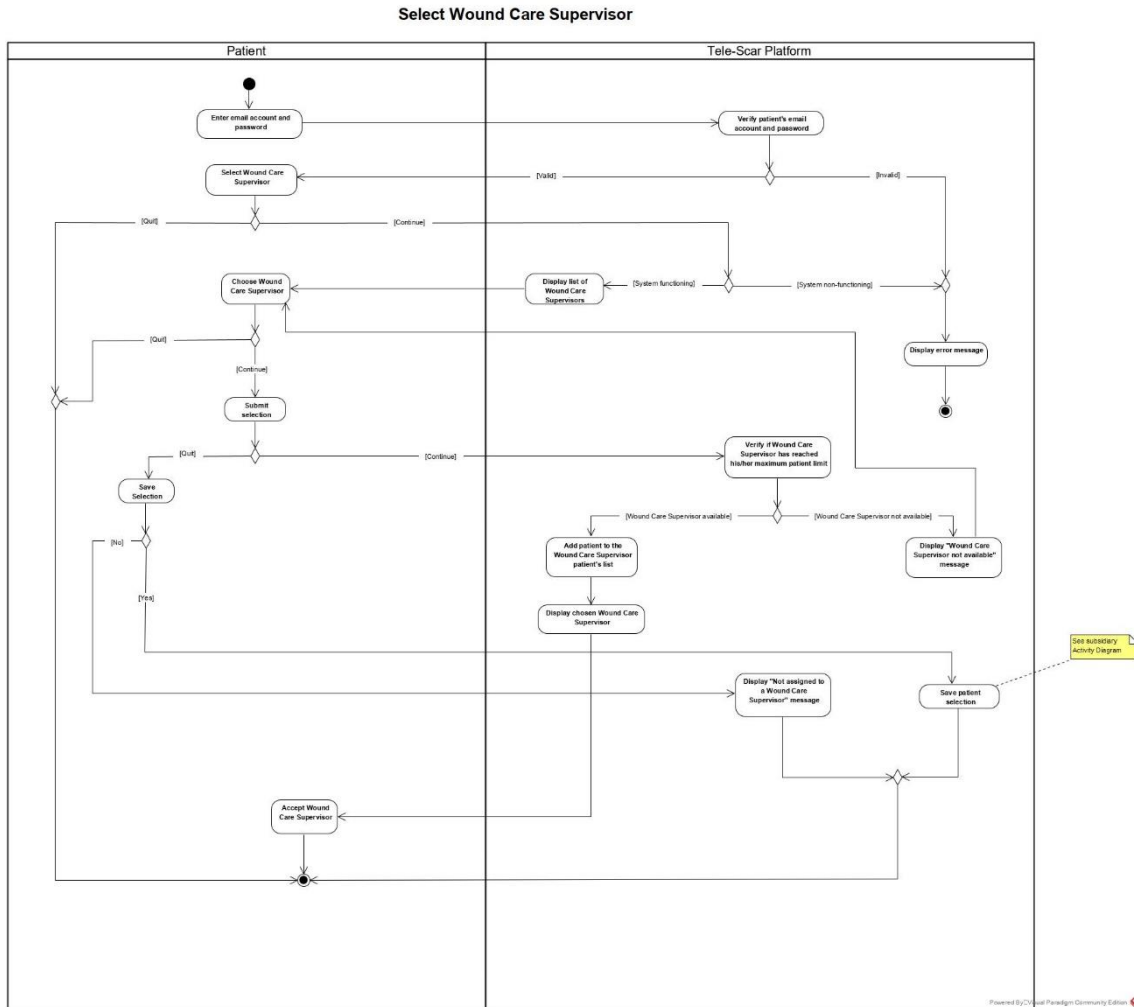
Cross-reference:

R8, R15

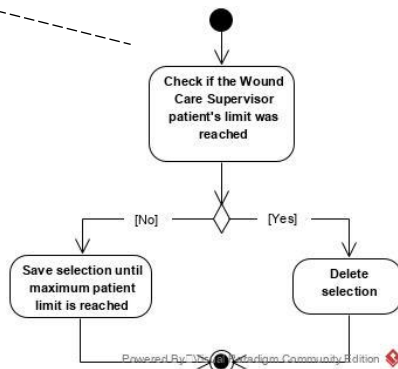
Appendix XVI – Activity Diagram: Subscribe to the Platform



Appendix XVII – Activity Diagram: Select Wound Care Supervisor

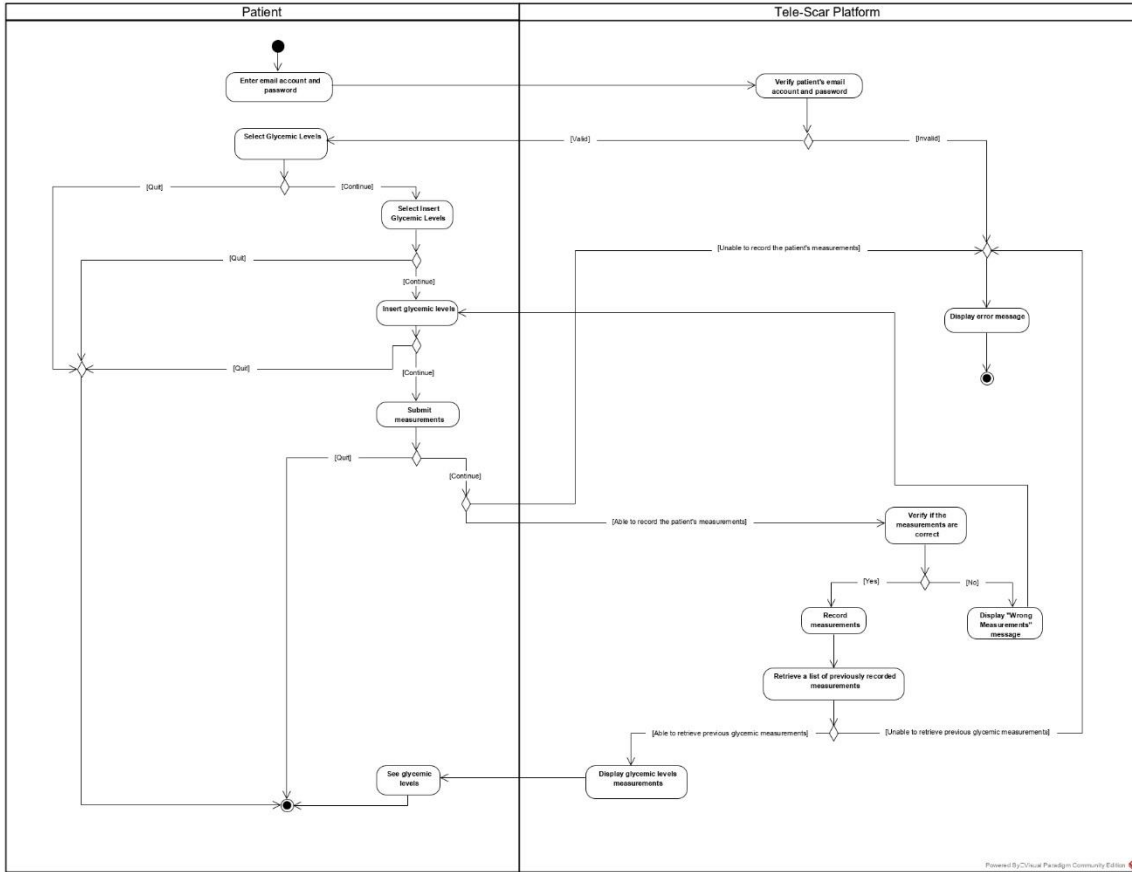


Subsidiary Activity Diagram



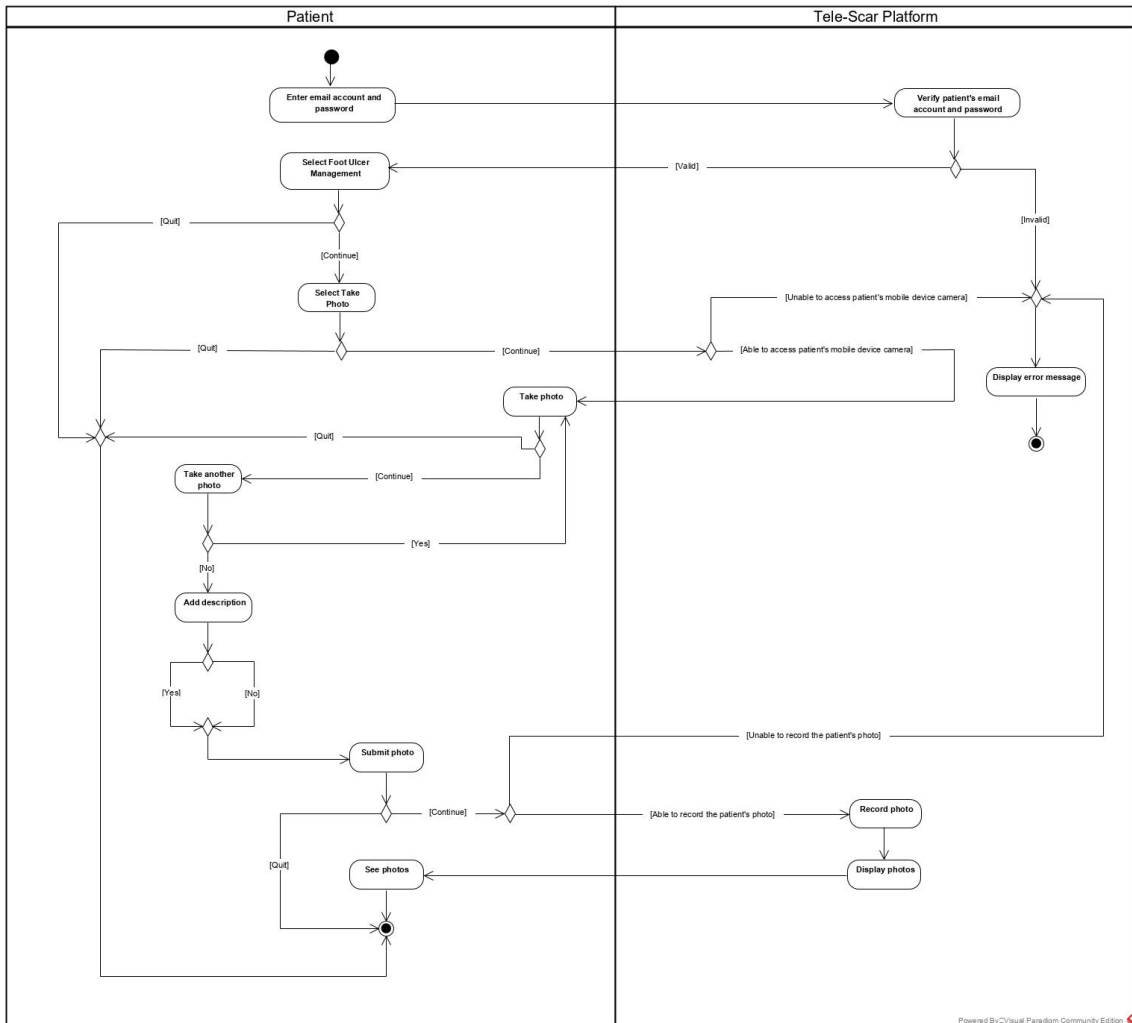
Appendix XVIII – Activity Diagram: Insert Glycemic Levels

Insert Glycemic Levels



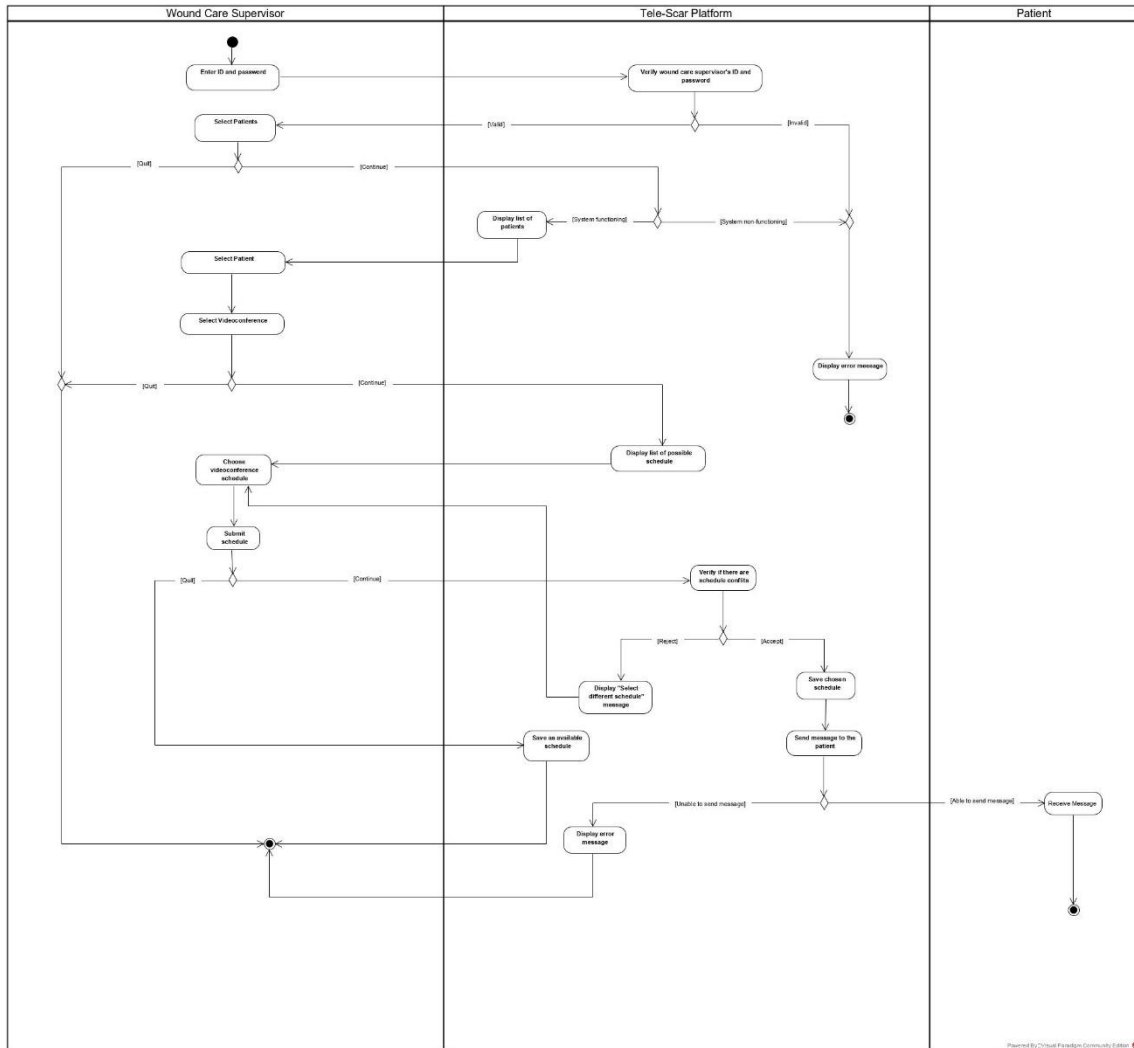
Appendix XIX – Activity Diagram: Upload Photos

Upload Photos

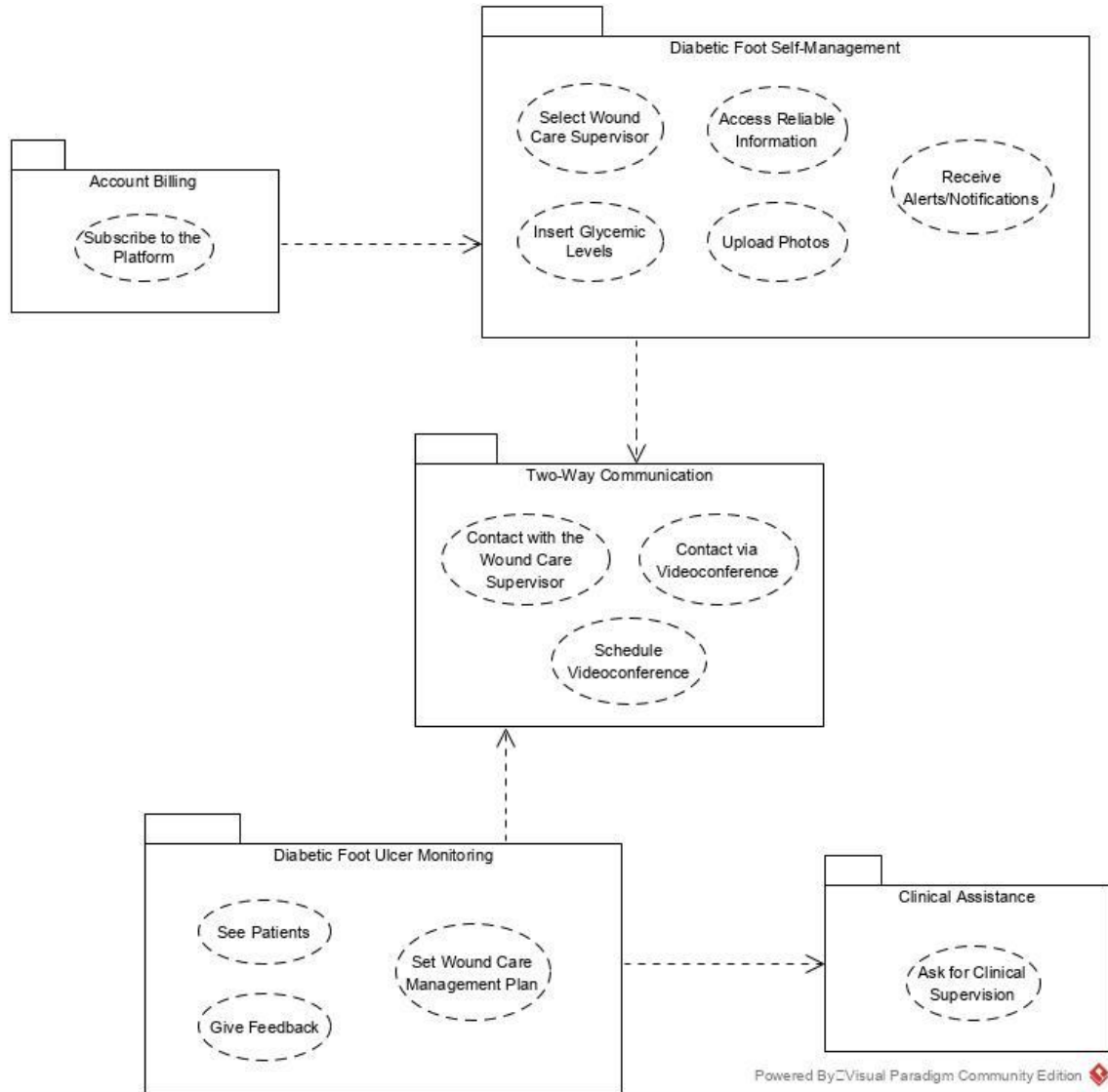


Appendix XX – Activity Diagram: Schedule Videoconference

Schedule Videoconference



Appendix XXI – Use Case Package Diagram



Appendix XXII – Video Link and Mockup Redmine

Video link:

<https://biteable.com/watch/tele-scar-platform-2629514/0968383524c3e025ad5df8dbc2d15ffe>

The resulting mockups for testing, are present in the Wiki page of the Catch-22 [TES Project] Redmine, under the topic “Mockup”.

Links:

[https://redmine.fe.up.pt/projects/catch-22tes_project/wiki/Mockup - Wound Care Supervisor](https://redmine.fe.up.pt/projects/catch-22tes_project/wiki/Mockup_-_Wound_Care_Supervisor)

[https://redmine.fe.up.pt/projects/catch-22tes_project/wiki/Mockup - Patients](https://redmine.fe.up.pt/projects/catch-22tes_project/wiki/Mockup_-_Patients)