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Understanding the Customer Experience in Healthcare for Pressure Ulcers

Ana Catarina Monteiro Azevedo

Master Thesis

Supervisor at FEUP: Professor Lia Patrício, PhD

Supervisor at Fraunhofer Portugal AICOS: Maria Vasconcelos, PhD

U.PORTO

FEUP FACULDADE DE ENGENHARIA UNIVERSIDADE DO PORTO

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To my family.

Abstract

A pressure ulcer is a skin injury, very common in Portugal and worldwide, which can lead to early death or severe disability if not adequately treated in time. The vast majority of the suffering and costs related to pressure ulcers care can be avoided if the problem is detected early through the efficient registration, characterization, and monitoring of pressure ulcers.

The purpose of this study is to understand the experience, contexts, activities, problems, and needs of pressure ulcers' stakeholders and how they cocreate value building upon this understanding.

This qualitative research is based on the Grounded Theory' tenets and consisted of twenty-five in-depth, semi-structured, individual interviews with healthcare professionals, informal caregivers, and patients. The interviews were recorded in audio and transcribed for content analysis supported by NVivo software.

Study results highlighted the need to streamline and systematize the process of documenting ulcers' care and improve image acquisition, which is considered a key visual component to patients' history. A new solution is needed to allow healthcare professionals to integrate resources (information, medical knowledge) and cocreate value (quick and easy access to information to discuss and decide on health treatments), contributing to patients' well-being and reducing the suffering and costs related to this clinical condition.

The results obtained from this study are currently being used to develop a new technology-based service related to mHealth to assist healthcare professionals in managing an electronic health record.

Resumo

A úlcera de pressão é uma lesão na pele, muito comum em Portugal e mundialmente, que pode levar a uma morte precoce ou incapacidade grave se não for tratada a tempo. A grande maioria do sofrimento e custos relacionados com os cuidados de saúde das úlceras de pressão podem ser evitados se o problema for detetado cedo através do registo, caracterização e monitorização eficientes das úlceras de pressão.

O objetivo deste estudo é perceber a experiência, contexto, atividades, problemas e necessidades dos atores envolvidos nos cuidados das úlceras de pressão e como eles cocriam valor baseado nesse entendimento.

Esta investigação qualitativa é baseada em elementos da Grounded Theory e consistiu em vinte e cinco entrevistas semiestruturadas e individuais com profissionais da saúde, cuidadores informais e pacientes. As entrevistas foram gravadas em áudio e transcritas literalmente para análise de conteúdo suportada pelo programa informático NVivo.

Os resultados sublinham a necessidade de agilizar e sistematizar o processo de documentação dos cuidados das úlceras de pressão e melhorar a aquisição de imagem, que é considerada um elemento chave visual do histórico clínico do paciente. Uma solução nova é necessária para permitir que os profissionais de saúde integrem recursos (p.e. informação, conhecimento clínico) e cocriem valor (i.e., acesso fácil e rápido a informação para discutir e decidir sobre tratamentos de saúde), contribuindo para o bem-estar do paciente e reduzir o sofrimento e custos associados a esta condição clínica.

Os resultados obtidos neste estudo estão a ser usados para desenvolver um serviço baseado em tecnologia relacionado com mHealth para auxiliar os profissionais de saúde a gerir registos de saúde eletrónicos.

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ICT – Information and Communication Technology

IT – Information Technology

PU – Pressure Ulcer

SD – Service Design

SD4VN – Service Design for Value Networks

1 Introduction

1.1 Project Background

Health has always been one of the main concerns of human beings, and several prehistoric pieces of evidence support this idea such as drawings, paintings, and sculptures in stones, which document several medical procedures, many related to wound treatment (Afonso et al. 2014). Being the skin the largest organ of the human body, which possesses multiple vital functions (Kanitakis 2002), serves as a protective barrier against the environment. The importance of keeping its integrity can't be overstated. Otherwise, large portions of skin injury can lead to significant disability or death (Singer & Clark 1999).

Pressure Ulcer (PU), also known as bedsore, is a "localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear" (NPUAP et al. 2014, p. 12). A pressure ulcer is a chronic wound very common worldwide – MedMarket Diligence found that there are approximately 4.5 million pressure ulcers in the world that require treatment every year[1] – and it frequently occurs in patients with limited mobility and/or with advanced age (Friesen et al. 2016). When pressure is applied to an area of the skin, it suffers from lack of oxygen and nutrients, which causes the ulcer to develop (Rodrigues et al. 2013). Pressure ulcers bring severe social impacts since it affects the quality of life of patients and their informal caregivers (Administração Regional de Saúde do Algarve 2017).

Although some researchers advocate that PUs are preventable, its incidence and prevalence continue to be high, even in developed countries. The EPUAP[2] conducted the first European PU prevalence study in 2001 and Portugal presented a PU prevalence of 12.5% in the country. The first national study in Portugal was done in 2007 and pointed out the prevalence of 31,3% when validating (nationally) the Braden scale[3], which decreased to 19,3% after that scale implementation (Afonso et al. 2014). More recently, the Rede Nacional de Cuidados Continuados Integrados presented an incidence of 2.3% and a prevalence of 8,9% (ACSS & SNS 2017). Nevertheless, according to Pordata, the aging index on Portuguese population increased five times from 1970 to 2016[4], which constitutes a forewarning to take preventive actions against the development of pressure ulcers.

Wound healing is a very complex, dynamic and lengthy process which involves several factors – skin condition, nutritional status and other pathologies that patients might have (Velnar et al. 2009) – which can quickly restrain skin from cicatrize. Additionally, pressure ulcers can manifest themselves as a secondary condition during admission to a hospital (Friesen et al. 2016) or in other care institutions. For these reasons, patients with pressure ulcers are admitted for longer and readmitted more often than average, drawing considerable resources from the National Health Service (DGS 2011).

The vast majority of the costs and suffering related to pressure ulcers care can be significantly attenuated if the problem is detected early. In fact, Direcção-Geral da Saúde (2011) states that

[1] Based on MedMarket Diligence website, "Wound prevalence and wound management, 2012-2020".
[2] European Pressure Ulcer Advisory Panel.
[3] Pressure ulcer risk assessment tool.
[4] Based on Pordata website, "Ageing indicators".

approximately 95% of pressure ulcers can be avoided if detected and treated early in its development. Diverse procedures are put into practice to ensure the proper prevention and treatment, such as frequent skin observation, repositioning of the patient, appropriate skin care, adequate nutrition and dressings and the use of medical equipment to relieve pressure (Ramos et al. 2017). Additionally, registration, characterization, and monitoring of pressure ulcers play a crucial role for early diagnosis, allowing a quick medical response to correctly establish the treatment required, delaying its development and, consequently, improving the patient's lives (DGS 2011; NPUAP et al. 2014). Rodrigues et al. (2013) emphasize the need to create a system to assist the ulcer prevention, ulcer monitoring, and all the treatment process. The goals of pressure ulcers' care are to reduce the pain, time and costs, but mostly, to promote wound healing.

1.2 Project Contribution

As the registration, characterization, and monitoring of pressure ulcers play a key role for early diagnosis, Rodrigues et al. (2013) propose the use of mobile information and communication technologies to ensure the access to information in real time. There has been a growing interest on information and communication technologies, in particular, mobile health (mHealth) solutions to improve the efficiency and ease the burden on health services, which resulted from the substantial evolution of smartphones due to their ubiquity, relatively low cost, and growing technological capabilities. For instance, the recent improvements to the camera and image quality opened up new opportunities for the registration of pressure ulcers, a chronic skin condition that is inherently visual.

There is a significant need to involve the customers and other relevant stakeholders on the creative process to generate innovative service ideas since they are the experts in performing the activities or tasks the service is intended to support. The goal of involving customers is to close the gap between what is needed and what is delivered and, consequently, develop a solution that fits exactly the needs and, not only to meet but to exceed customers' expectations.

The purpose of this research is to understand the customer experience of multiple actors involved on pressure ulcers 'care (healthcare professionals, such as doctors, nurses and pharmacists, patients and informal caregivers, such as family members), through a service design perspective. Understanding the customer experience means to understand their context, activities, problems, and needs. Knowing what people think and do when facing a problem or need, improves the efficiency and effectiveness of the service to be designed and, therefore, contribute to better service experience.

The results will help to understand how technology-based services, namely, mobile health solutions, can assist registration, characterization, and monitoring of pressure ulcers, improve the overall health experience of the stakeholders regarding healthcare provision and, consequently, patient outcomes.

The core foundation of this research is to integrate service design and innovation to develop technology-enabled services for complex health value networks related to pressure ulcers. Considering the purpose of the study, mHealth will be the service concept to be explored. One innovative aspect of this investigation is the use of service design for value networks (SD4VN) (Patrício, Pinho, et al. 2018) to study the experience of pressure ulcers' stakeholders.

1.3 Research Questions and Objectives

The following research question will help to address the need stated before:

Research Question: What are the experiences of pressure ulcers' actors and how do they cocreate value?

Objective: To understand how information and communication technologies (ICT) can improve the pressure ulcers' care.

The results obtained from this study will be useful to design and determine the applicability of mHealth solutions for pressure ulcers' stakeholders.

1.4 Institution Characterization

The Associação Fraunhofer Portugal Research is a Research Center for Assistive Information and Communication Solutions (FhP – AICOS), a non-profit private association founded by Fraunhofer-Gesellschaft, the largest organization for applied research in Europe (Fraunhofer Portugal 2016), aiming to explore technology innovations, contributing to the market success of its clients' products and services and increasing value for their customers (Fraunhofer Portugal 2017b).

"Remarkable Technology, Easy to Use"

FhP-AICOS focuses its activity in the area of assistive information and communication solutions for the health sector, with a particular focus on the development of mHealth solutions, offering competencies centered on end-user experience and intuitiveness and usability of applications. This type of solutions enhances people's lives due to the capability of facilitating their access to ICT. It supports aging and older adults in the process of aging well at home, in the community, and at work; develops social well-being and the improvement of the quality of life of its end-users; promotes cost reduction of health and social care (Fraunhofer Portugal 2017b).

The "Understanding the Customer Experience in Healthcare for Pressure Ulcers" dissertation is within the Medical Pre-Diagnosis System project, which aims to foster early diagnosis through medical images, with a strong mobile component, that allows easy image acquisition, transmission and automated analysis in several clinical contexts, in particular, for skin ulcers (Fraunhofer Portugal 2017a).

1.5 Report Outline

The report is structured as follows:

- Section 2 reviews literature on customer experience, value cocreation and informatics in healthcare services.
- Section 3 describes the qualitative research approach, including sample, data collection, and analysis.
- Section 4 presents the results of the qualitative research, through a service design for value networks.
- Section 5 provides recommendations for a new service based on the needs identified and explains how ICT affects the different actors involved.
- Section 6 concludes the research and proposes future research opportunities.

2 Literature Review

This section reviews the literature on customer experience, value cocreation, and informatics healthcare. Since the research is applied to a specific clinical context, a brief review was conducted on pressure ulcers' care to gain a first understanding of the area.

2.1 Understanding the Customer Experience

Customer experience can be defined as the internal and subjective responses to any contact with a company (Meyer & Schwager 2007). The meaning of customer experience was further extended to the customer's cognitive, emotional, affective, physical, and social responses to a firm's offerings during the customer's journey (Verhoef et al. 2009; Lemon & Verhoef 2016).

Since customer experiences are central to service-dominant logic, it is important to study the role of the customer in value co-creation (Lusch et al. 2007). Services can be defined as the application of specialized skills and knowledge as the fundamental unit of exchange (Vargo & Lusch 2004). Most industrialized countries have become service economies (Foglieni et al. 2018), and the importance of services continues to grow in the global economy (Patrício & Fisk 2013). More than adding value to products, providing services comprises the understanding of individuals and organizations, brought together into networks, who are engaged in the cocreation of value (Lusch et al. 2007).

Service innovation, the key to economic and social development, can be defined as the design and development of new and/or improved service offerings or services processes (Patrício, Gustafsson, et al. 2018) and can enhance value cocreation among providers and customers (Michel et al. 2008). Technology is a critical operant resource for value cocreation and service innovation (Akaka & Vargo 2014).

Innovation in services inevitably leads one to study about the role of service design as a driver of innovation (Foglieni et al. 2018) and its ability to bring innovative ideas to life through a design thinking process (Patrício & Fisk 2013). It captures insights from people, as well as their experiences, problems, needs, and preferences, and creates innovative ideas that reflect what customers want, bringing value for them (Brown 2008).

Service design (SD), is a human-centered, holistic and iterative approach to service innovation that interactively enables customers to cocreate valuable experiences. SD involves four different stages, starting from *exploration* (related to the understanding of the customer experience), passing to *ideation* (associated with the designing of the service offering) and *reflection* (compared to the service experience prototyping) and finalizing with i*mplementation* (Brown 2008; Stickdorn et al. 2011).

This research focuses mainly on understanding the customer experience to generate ideas and developing new service solutions for healthcare. Customer experience is tightly connected to value cocreation, the primary basis of innovation, focusing on the actors' ability to integrate resources (Ciasullo et al. 2017). The concept of customer experience and value cocreation has been studied, particularly in healthcare (Pinho et al. 2014; Beirão et al. 2017; Patrício, Pinho, et al. 2018).

Customer Experience and Value Cocreation in Healthcare

Value cocreation, a central concept in service-dominant logic, refers to the actions of multiple actors that contribute to each other's well-being (Vargo & Lusch 2016). Value networks can be defined as the interactions of multiple actors, through institutions and technology, to coproduce and exchange service offerings, and to cocreate value (Lusch et al. 2010). To understand how value is cocreated, it is important to study the relationships and interactions in complex networks (Gummesson 2007). In the context of healthcare, McColl-Kennedy et al. (2012, p. 370) defined customer value cocreation as ''benefit realized from integration of resources through activities and interactions with collaborators in the customer's service network".

The number of actors involved in complex service environments such as healthcare is substantially high, therefore, "value is cocreated through webs of interactions between provider networks and customer networks" (Patrício, Pinho, et al. 2018, p. 76). Health organizations have to "manage complex interactions between several different actors or entities" such as patients, healthcare professionals and suppliers (Ciasullo et al. 2017, p. 4). Service design for healthcare focus not on the service or company, but in value networks where actors collaborate and integrate resources to create value for all (Pinho et al. 2014). Therefore, it is relevant to have a network perspective in healthcare services since "patient well-being can only be achieved through the joint efforts of interrelated provider networks (e.g., other healthcare organizations) and patient networks (e.g., formal and informal caregivers)" (Patrício, Pinho, et al. 2018, p. 1).

Understanding the customer experience and designing services for value networks of interdependent actors requires a method which can capture such complexity at different levels. Service Design for Value Networks is a "method for designing services as enablers of many-to-many value cocreating interactions, striving for balanced centricity among network actors" (Patrício, Pinho, et al. 2018, p. 1). A "new or renewed approach to the integration of resources" can contribute to innovating the way actors cocreate well-being and "new interactions among and between the different actors directly or indirectly involved in the healthcare system" (Ciasullo et al. 2017, p. 5). Technology offers new possibilities to develop new health services to improve actors' interactions and value cocreation (Ostrom et al. 2015).

Value cocreation in complex multi-actor, network settings is considered a research priority, particularly in healthcare, to understand further how different actors achieve service innovation through resources integration such as information and technology (Ostrom et al. 2015; Ciasullo et al. 2017).

2.2 Overview of Pressure Ulcers' Care

Considering that pressure ulcers' care is framed in the scientific field, vast literature provides scientific support for the treatment and management of wounds (Clark et al. 2006; Crisp et al. 2012; Afonso et al. 2014; NPUAP et al. 2014). The purpose of this subsection is not to review the science of pressure ulcer management, but to obtain awareness of the clinical context that characterizes it.

Treating a patient who carries a wound is a complex process that requires a rigorous, effective and efficient approach, supported by scientific and technological knowledge. The primary

goals of treating a wound are to prevent infections and to promote wound healing. Depending on the type of wound, the healing process can become longer and more complicated. Wounds can be classified as acute (surgical or traumatic) or chronic (pressure ulcers, diabetic foot, leg ulcers, oncological wounds or atypical wounds) (Crisp et al. 2012; Afonso et al. 2014).

Processes

Regarding pressure ulcers' care, it is possible to identify three main processes – prevention, treatment, and monitorization. Prevention aims to avoid the skin breakdown, resulting in pressure ulcers, by maintaining regular skin inspections, repositioning the patient, skin hygiene, prevent friction and monitor the patient's nutrition and hydration (Crisp et al. 2012). Treatment is mostly based on three phases: evaluation, cleaning, and selection of the ideal therapeutic option (dressings); monitoring ensures the skin surveillance and the monitorization of pressure ulcer risk development (Afonso et al. 2014). Monitoring consists mostly of skin surveillance and documenting relevant information about the patient and the ulcer to monitor the healing process and evaluate the success of the care management (Crisp et al. 2012).

Registration and Information Needs

Related to the registration and characterization activities, one can identify the initial diagnosis, pressure ulcer characterization, pressure ulcer evaluation and pressure ulcer risk assessment. Initial diagnosis includes medical history, a physical exam, wound characterization and wound evaluation. Additionally, it is essential to evaluate pain, nutrition, quality of life, conditions and risk factors, and psychosocial health (Afonso et al. 2014). Wound characterization consists in assigning a degree to classify the ulcer stage or category and should be done accordingly to the pressure ulcer classification system NPUAP/EPUAP (Crisp et al. 2012; NPUAP et al. 2014; Afonso et al. 2014). Wound evaluation should contemplate the aspects presented in Table 1 (Afonso et al. 2014).

Characteristic	*Description*
Location	Identifies the local where the ulcer has developed.
Dimensions	Characterizes the ulcer regarding length, width, and depth.
Exudate	Refers to the fluid that an ulcer may expel resulted by inflammation.
Existence of fistulas and/or fistulous paths	Identifies the presence of a fistulous path and its depth.
Wound edges/margins and perilesional skin/surrounding tissue	Identifies the integrity of the surrounding tissues.
Odor	Identifies the smell and it can be present or absent.

Pain	Identifies the pain caused by the ulcer and it can be nociceptive, neuropathic or idiopathic. It can also be classified as acute or chronic.
Type of tissue/wound bed	Characterizes the ulcer tissues in terms of necrosis, fibrin, granulation or epithelialization.
Signs of critical colonization / infection	Identifies states of critical colonization and infections that can delay, stagnate or hamper the healing process.

Table 1 – Ulcers' Characteristics

Pressure ulcer risk assessment is fundamental to plan and implement measures for its prevention and treatment. For this purpose, it was developed assessment scales which are instruments that make possible a systematic and measurable evaluation and that help to identify patients at risk (Afonso et al. 2014). There are several risk assessment scales for pressure ulcers; some were review by Frade (2017). However, the Braden Scale was translated and validated to the Portuguese population and consists of a DGS standard for its application (DGS 2011). An additional type of registration is the photographic record which, with informed consent, is not only a useful complement in the parameterization and evaluation of the wound but also fundamental to capture a temporary situation in a visual way (Afonso et al. 2014).

Key Actors

The management of pressure ulcers requires a global and multidisciplinary approach (Afonso et al. 2014), which includes the interaction of different healthcare actors and institutions. The patient is the focus of pressure ulcers' care (NPUAP et al. 2014). The nurse is expected to prevent and manage pressure ulcers due to education received on maintaining skin integrity, however, there are situations where nurses require advice from other health professionals, such as dietitians and physiotherapists, doctors and other healthcare professionals, such as the pharmacists, in the prevention and management of pressure ulcers (Samuriwo 2012). It is also important to consider the role of informal caregivers who ensure the proper informal care to patients who are not capable of doing it by themselves. Maintaining cutaneous integrity and avoiding lesions results mostly from the work of the caregiver team and not so much the general condition of the patient (UMCCI 2011).

The literature reviewed in this topic provided a brief overview of pressure ulcers' care, namely related to the processes, activities, information needs and actors. Although there are several studies about the best practices related to the prevention, treatment, and monitorization of pressure ulcers, a different perspective of research about the contexts, the interactions, the needs and the problems around each activity and process remains very limited.

2.3 Informatics in Healthcare

In healthcare services, innovation is crucial to improving human well-being. Healthcare innovation can be defined as "the introduction of a new concept, idea, service, process, or product aimed at improving treatment, diagnosis, education, outreach, prevention and research, and with the long-term goals of improving quality, safety, outcomes, efficiency and costs" (Omachonu 2010, p. 5).

Technology became the most significant innovation in healthcare and continued to evolve. Since it substantially changed the way services are delivered and experienced by the customer, it is incredibly relevant to design services in a way that embrace technology. Technology-enabled services allow customers to increasingly create their own experiences more dynamically and autonomously (Patrício et al. 2018).

Healthcare Informatics is defined as "the integration of health-care sciences, computer science, information science, and cognitive science to assist in the management of healthcare information" (Saba & McCormick, 2015, p. 232 cited in Sweeney (2017)). According to Omachonu (2010, p.5), information technology (IT) "remains a key driver of innovation in healthcare". The same idea was previously supported by Burns (2005), stating that information technology holds the highest potential in the healthcare experience, contributing to positive changes for patients and their families, such as fast and reliable diagnoses, fewer medical errors and less wasted time from duplicative information requests in the treatment process. IT can add valuable experiences to the service-provision process by enabling more collaboration and, therefore, innovation throughout the entire value network (Lusch et al. 2007). It can also improve communication, time-management, and delivery of information amongst professionals and patients (Sweeney 2017).

2.3.1 Information and Communication Technologies for Healthcare

Silva et al. (2015) state that health institutions and systems have been using ICT to improve quality, safety, and productivity of healthcare services. In the delivery of healthcare, ICT is "about health professionals making better treatment decisions, hospitals providing higher quality and safer care, citizens making informed choices about their health, and governments becoming more responsive to health needs" (Dzenowagis 2005, p. 5).

One of the most recent types of ICT solutions in healthcare is mobile Health. mHealth can be briefly translated into the use of advanced mobile technologies and innovative mobile applications to support health objectives (Kay & Santos 2011, Steinhubl et al. 2013). The recent and growing interest in mHealth is related to the outstanding evolution of smartphones and the emergence of online application stores which allow the delivery of mHealth applications directed toward patients and healthcare professionals (Silva et al. 2015). mHealth opens up the opportunity to deliver medical support when and where people need (Boulos et al. 2014) since it can overcome geographical, temporal and organizational barriers, and, therefore, improve health and well-being (Kay & Santos 2011).

Smartphones are incredibly portable, widely available with relatively low cost and include high-resolution cameras and internet connections allowing an easy and fast access to information. These are some of the most relevant features which make smartphones and, consequently, mobile health applications, a valuable resource in the health sector (Santos

(2011) and Salomé & Ferreira (2018)). The ubiquity of smartphones is well-known worldwide and, in Portugal only, the possession of smartphones has increased more than two times from 2012 to 2017, which can be translated in 6,8 million of individuals who owned a smartphone in 2017[5]. The continuous growth on the number of mobile health applications as a consequence of the evolution of the smartphone, there were 325,000 health apps available in 2017 (health & fitness and medical apps) and 78,000 new health apps were added to major app stores in the last year (Research 2 Guidance 2017).

Mobile technologies enhance the connection between patients and the health community, especially in long-distance situations, where patients were given the opportunity to manage their chronic diseases from home through the access of medical expertise and knowledge in real-time (Kay & Santos 2011). Steinhubl et al. (2013) reinforced the same idea, saying that mHealth empowers patients to take an active role on his health and self-monitoring his condition and, consequently, minimize the need for office visits, contributing to reduce healthcare costs and redirect attention and time of professionals to the patients who need them most. The same author mentioned, as an example, patients with chronic health conditions who can use mHealth to ensure better diagnosis, treatment, and control of those conditions through a safe, effective and informed management from home.

Since pressure ulcer is a chronic health condition, the opportunity to explore the benefits mHealth could bring to manage this severe condition becomes more and more needful. Boulos et al. (2014) conclude their research by pointing out the lack of studies on the effectiveness of mobile health applications and suggest that more research is needed to investigate the validity of smartphones and mobile apps in the context of healthcare.

mHealth for Pressure Ulcers

Considerable attention has been giving to the use of mobile health solutions to improve the registration and access to information related to pressure ulcers' care and, consequently, efficiently provide the best medical care. Numerous researches present mHealth solutions for pressure ulcers care such as the ones proposed by Santos (2011), Rodrigues et al. (2013), Parmanto et al. (2015), Friesen et al. (2016) and Salomé & Ferreira (2018). These studies have gathered important findings such as:

- The convenience for healthcare professionals to have a portable tool for registration and access of clinical information of patients (create a new patient record, view existing records, enter new wounds, assessing existing wounds), resulting in time saved with each wound assessment and more time for care itself;
- The use of scale evaluations (e.g., Braden Scale (Rodrigues et al. 2013)) and data to aid the classification, treatment and monitorization of ulcers, describing ulcers' characteristics and status;
- The ability to schedule reminders for skin checks, patients turns, wound assessment or treatment, resulting in efficient time management;

[5] Based on the Marketest study "3 em 4 utilizadores de telemóvel usa smartphone", January 2018.

- The relevance and value of wound image, not only as additional information to the written description, but also as a visual resource for wound comparison and illustrative timeline;
- The necessity for healthcare professionals to have a device with them when checking all the patients on their shifts, which may reduce the problems referred to when using a paper-based registration type;
- The benefit in designing the application not only for healthcare professionals but also for patients and their informal caregivers, mainly because patients not always have healthcare assistance to evaluate the possibility of developing pressure ulcers, and daily skin evaluations are critical to detecting skin redness to take an immediate action to avoid skin breakdown;
- The suggestion for developing a glossary of specialized terms.

Aside from theoretical researches, there are also several mobile applications on the app market which follow the same findings mentioned before, allowing to register and share information and monitor wounds. Some examples are: PointClickCare Skin and Wound, mPOWEr, Tissue Analytics, +WoundDesk, Wound Care Buddy, Lesioni da decubito LITE, Wound Analysis, MOWA - Mobile Wound Analyzer, Wound Central, Wound Tracker Professional, WoundSmart, Swift Skin & Wound, Wound Pro, Smart Wound Care, Wound Care Assistant and Pressure Ulcer. To do so, an image of the wound is taken and stored, data is collected to classify and characterize an ulcer according to the information and scales defined, allowing the user to have a timeline (visual and written) of the wound. Other mobile applications have a different purpose, such as to provide general information about pressure ulcers' care – Lesioni da decubito LITE, Wound Care Management, Choose a Dressing, Wound+, Wound Hub, PUInfo. Both types of mobile applications are available for IOS and/or Android app stores and its target is mostly medical professionals, but also patients or consumers in general. According to the developers, some of these applications have been developed by or with healthcare professionals, but few co-design evidence are presented.

In short, mHealth solutions for pressure ulcers aim to optimize the preventive process of early diagnosis of skin damage, the treatment process through the fast and easy informed medical decision, and the monitoring process of track ulcers' evolution.

Healthcare services are the most complex services in the modern economy due to its variability and uncertainty. The complexity of care process and healthcare organizations have imposed challenges in technology development to capture and rationalize clinical services (Burns 2005). The use of informatics affects the process and flow of the clinical setting, as such, it is essential to consider not only the technology but also the workflow and the data collection process (Sweeney 2017). Moreover, "as technology innovation rapidly changes service experiences, service designers need to leverage technology and orchestrate complex service systems to create innovative services while enabling seamless customer experience" (Teixeira et al. 2017, p. 240). In short, research on understanding the customer experience will provide the necessary insights to leverage technology in this complex healthcare value network effectively and further expand knowledge on this topic.

2.4 Summary and Research Gaps

As reviewed in this chapter, the *extensive literature on pressure ulcers' care has been done focusing on the scientific care or the technology component. This investigation addresses a different perspective by focusing on the experiences, activities, contexts, interactions, needs and problems, namely related to information needs.*

The benefits that information technology can bring to healthcare are more than evident in the literature. However, most of the innovations in healthcare usually assume an output-centric focus (Ciasullo et al. 2017). The research found on mHealth for pressure ulcers tend to follow a technology-oriented thinking, in which technological devices are the focus of the consumer task (Maldé 1981). Services should be design in a way that brings benefit to a broader variety of consumers. Therefore, a more consumer-oriented approach, in which the consumer lies at the center of the task, should take place. This approach must be based on needs, preferences, skills, and knowledge of the user (Maldé 1981) to ensure product/service market-fit. Moreover, adopting a consumer-oriented approach means to understand the customers and their experiences, by talking directly with them and discover what they do, want and need, and what challenges they want to overcome.

In this line of reasoning, this research explores, through a service design approach, the experience of pressure ulcers' stakeholders, focusing on the use of technology to leverage value cocreation activities in a complex value network. As research priorities, is evident the need to investigate service innovations in healthcare services, specifically, understanding organization and employee issues relevant to successful service, understanding value creation, enhancing the service experience, improving well-being through transformative service and leveraging technology to advance service (Ostrom et al. 2015).

3 Methodology

Given the qualitative aspect of the research objectives – understand customers' experiences –, some tenets of grounded theory methodology were used to outline the investigation. Twenty-five individual semi-structured interviews were recorded in audio and transcribed for content analysis supported by the NVivo software.

3.1 Qualitative Research Approach

Kothari (2004) explains that the research purpose is to discover answers to questions by applying scientific procedures and that each research has its specific purpose. The same author points out two basic approaches to research: the quantitative approach and the qualitative approach. In short, the quantitative approach is used to understand a phenomenon that can be expressed in terms of quantity and the qualitative approach is used to understand a phenomenon that can be expressed in terms of quality. The decision to choose among these two relies on what one is interested in investigating.

Creswell (2007, p.40) presents three reasons for choosing and conducting a qualitative research: (1) the need to explore a problem and a complex, detailed understanding of the issue, which can be done by talking directly with people and empower them to share their stories; (2) the wish to understand the contexts or settings in which participants in a study address a problem or issue; or, (3) the need to develop theories to capture the complexity of the problem being examined.

Since this research aims to achieve these same goals, it becomes relevant to use the qualitative approach to understand the several perspectives of the different actors in pressure ulcers' care and explore a complex phenomenon as healthcare. Naturally, quantitative methods should not be overlooked since they can complement the research, but the primary focus relies on the exploration of a complex and understudied topic. Accordingly, rather than trying to understand this phenomenon through numbers with questions such as "how much" or "how many", the study is based on words, with questions such as "what", "how" or "why" (Bricki & Green 2007).

The next step is to choose the appropriate methodology, which is viewed by Kothari (2004) as the way to scientifically and systematically solve the research problem, with the various steps and logic for studying it. In his book, Creswell (2007) introduces five qualitative approaches to inquiry – Narrative, Phenomenological, Grounded Theory, Ethnographic and Case Study – which are the five types of qualitative research most frequently seen by the author in the social, behavioral and health science literature. The study was based on Grounded Theory' tenets related to sample design, data collection, and data analysis and guided the investigation to explain how people are experiencing a phenomenon, based on the data from the participants who have experienced the process (Creswell 2007).

3.2 Sample Design

A theoretical sampling procedure was followed to select participants, and so, as the data was being collected, sampling evolved according to the relevance to the study (Charmaz 2006).

Having in mind the clinical context of the research, an initial literature review was conducted to define the first sample to be interviewed. Nurses, doctors, patients and informal caregivers were identified, and later during data collection, pharmacists were also identified.

In healthcare organizations, the participants were identified by the director or service responsible, according to their availability and willingness to participate. Concerning the patients, their ability to comprehend the study purpose and questions, to communicate and be willing to participate in the study constrained the selection. In such cases, the director or another service responsible determined the availability and their physical and mental ability to participate in the study.

Several types of healthcare institutions in different geographic locations were considered to obtain a broader insight on different perspectives. Twenty-five different actors (doctors, nurses, pharmacists, patients and informal caregivers) were interviewed (see Table 2).

From these interviews, twenty were healthcare professionals; four were caregivers and one patient. Sample saturation, meaning that further data does not sparkle new insights about the categories or its properties (Charmaz 2006), was reached for healthcare professionals. However, due to time and availability constraints and the ability to participate, the sample size was limited for informal caregivers and patients. Given these limitations, data analysis focused on healthcare professionals, and the remaining interviews were used to support the understanding of the overall experience.

	Long Term Care Facility	*Retirement*	*Pharmacy*	*Public Hospital*	*General*	***Total***
Nurses	11	3		1		15
Doctors	2					2
Patients	1					1
Pharmacists			3			3
Informal Caregivers		1			3	4
Total Interviews	14	4	3	1	3	25
Organizations	2	1	2	1		6

Table 2 – Sample design

3.3 Data Collection

The data was collected between the 8th of March and 29th of May through individual semi-structured interviews and were conducted face-to-face on the health organization's premises and participants' homes, with an approximate total of nine hours (see Table 3).

The semi-structured focused questions (see Appendix B: Interview) aimed to guide the interviews and gather specific and relevant information, but flexible enough to explore other aspects that spontaneously revealed to be significant. Interviews are well suited for the

research purposes because it allows an in-depth exploration of a particular topic with the person who has experienced it (Charmaz 2006). Considering the research purpose, the interview questions followed a service design and value cocreation perspective, where participants were invited to talk about their experiences, goals, roles, activities, tools, challenges, interactions with other actors, and the health information exchanged (McColl-Kennedy et al. 2012; Patrício & Fisk 2013).

A brief literature review of pressure ulcers' care occurred at the beginning of the study so that the researcher could have a certain familiarity with the research topic. The researcher's knowledge and experience allowed framing questions that would capture the relevant information. This process provided a place to start, but the purpose is to remain as open as possible to whatever is seen in the data analysis (Charmaz 2006).

To guarantee that all participants have been fully informed about the research and they participate in the interviews of their own free will, the informed consent was provided to the participants before starting each interview, and the interviewees and the research investigator signed it. A research protocol was always provided to the health institutions and, in case of the hospital, the study protocol was submitted and approved by the ethics committee. The information about the participants was kept confidential, the analysis of the data collected in the study was done anonymously, and the access to that information was very limited. Lastly, no potential risk was identified for the interviewees, except for a possible inconvenience about the time spent in the interview.

Participant	Healthcare Professional (n = 20)	Informal Caregiver (n = 4)	Patient (n = 1)	**Total (n = 25)**
Average	00:21:36	00:15:32	00:38:29	
Total	7:11:54	01:02:07	0:38:29	08:52:30

Table 3 – Interviews Length

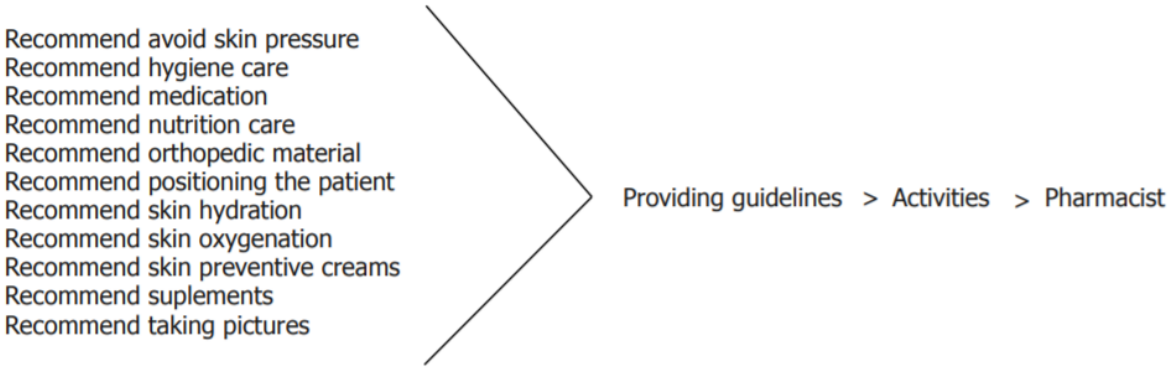
3.4 Data Analysis

To allow an in-depth analysis of the gathered data, the individual interviews conducted were recorded in audio and transcribed literally for content analysis supported by the NVivo 11 software. NVivo 11, a computer-assisted qualitative data analysis software, was used to assist the research regarding storing, organizing and retrieving data, especially relevant for studies with large amounts of data (Foley & Timonen 2015). Keep in mind that coding is an interpretative process (Charmaz 2006), and so, it is done by the researcher and not by the software (Foley & Timonen 2015).

This analysis involves a qualitative coding, where a label is attached to a segment of data describing what the segments are about (see Figure 1 for an example). Interviews were subject to three phases of coding: initial coding, where each word, line or segment of the written data is coded; focused coding, selecting the most significant and frequent initial codes; axial coding, relating categories to subcategories to synthesize and organize the codes. The coding process is iterative, meaning that labels, categories, and relationships are continuously reviewed and restructured. Having the coding process concluded, one can reach an

understanding of the studied experience (Charmaz 2006). Based on this analysis, the results (chapter 4) were systematized and modeled through a service design approach.

Figure 1 – Coding Process Example



4 Results

The purpose of this chapter is to provide the key results obtained from the data analysis based on qualitative coding. The results highlight the context in which interactions and value cocreation occur, the processes, activities, goals, and perceptions of the pressure ulcers' actors.

The richness of the data and the complexity of healthcare services imply an organized and visual systematization to support the exploration of new service possibilities. Results are organized in two main sections – understanding actors' experiences and health information management. The relevance of the two sections is evident since it addresses the research question and objective.

To understand actors' experiences, it was incorporated contributions from the Service Design for Value Networks to characterize interrelated experiences of the different actors (Patrício, Pinho, et al. 2018). The study is based on the first two stages of SD4VN, which involves mapping the value network and understand multiple actors' experiences and interactions. To understand how health information is managed, it was analyzed how different actors register, access and share clinical data, and what tools they use to do it.

Qualitative coding allowed to identify themes and concepts (Table 4) to organize and analyze better the data and have a detailed comprehension of the actors' experiences, which will be explained in the next subsections. The main categories identified were: roles, goals, interactions, activities, information, pains, suggested improvements and 'other' (a category that gathers information that does not fit in the other categories identified). The interactions, pains and 'other' were too specific for each actor, and so, too complex to aggregate, being used to enlighten the following subsections.

Categories	Subcategories	% (n=25)	Quotes	Actors
Role	Alert and recommend	12%	When we are at an early stage of an ulcer, our role is to alert for potential ulcer development (pharmacist).	Pharmacist
	Receive care	16%	I received treatment at home from the healthcare center (patient).	Patient
	Provide formal care	60%	We are the ones who execute and solve the most (nurses).	Nurses
	Provide informal care	4%	My role is to provide the maximum support as possible... whatever she needs... (informal caregiver).	Informal Caregivers

Categories	Subcategories	% (n=25)	Quotes	Actors
	Provide support	8%	I occasionally intervene when complications happen (doctor).	Doctors
Goals	Avoid infectious occurrences	20%	Trying to prevent the ulcer from infecting (doctor, nurse).	Nurse, Doctor
	Heal pressure ulcers	60%	I think the main goal is always to try to heal the ulcer (nurse).	Nurse, Doctor, Patient
	Patient well-being	24%	To have the maximum comfort as possible according to the situation (nurse).	Pharmacist, Nurse, Doctor, Informal Caregiver, Patient
	Prevent pressure ulcers	28%	Primarily to work aiming to prevent pressure ulcers (nurse). Trying to prevent the development of new ulcers caregiver).	Pharmacist, Nurse, Doctor, Informal Caregiver, Patient
Activities	Monitorization	84%	I check the patients every day (doctor). Based on the ulcer's characteristics over the time, we monitor if the treatment is working (nurse).	Nurse, Doctor, Informal Caregiver
	Prevention	100%	We are positioning the patient every three hours at least (nurse).	Pharmacist, Nurse, Doctor, Informal Caregiver, Patient
	Treatment	68%	We check the ulcer's status, and we choose the appropriate dressing accordingly (nurse).	Nurse, Doctor
Information	Access to information	80%	The information system is consulted every day by the doctor and the nurse (doctor).	Nurse, Doctor, Pharmacist

Categories	Subcategories	% (n=25)	Quotes	Actors
	Image	80%	I think the image always helps because it is an easy way for us to understand if the ulcer has improved or aggravated (nurse). I think the image is definitely important (doctor). The image is an informative element about the skin lesions' evolution (pharmacist).	Nurse, Doctor, Pharmacist
	Patient and ulcer data	80%	I need to know the size, depth, exudate, surrounding tissues… (nurse).	Nurse, Doctor, Pharmacist
	Register information	60%	An important thing we must do is mainly the registration because it must always be a record of the ulcer's condition at a given moment (nurse).	Nurse
Suggesting Improvements	Improve registration	60%	I think it would be preferable to have an information system, it would be more accessible (nurse).	Nurse, Doctor, Pharmacist
	Guidelines	28%	Provide guidelines to caregivers (…) greater monitoring by the doctors, pharmacists, nurses (pharmacist).	Pharmacist, Nurse
	Support	4%	We, caregivers, we need a lot of support, the patients need a lot of support, but we need more (informal caregiver).	Informal Caregiver

Table 4 – Categories of Qualitative Coding

4.1 Understanding Actors' Experiences

Complex environments such as healthcare involve multiple actors, consequently, experiences are also influenced by many interactions. As such, a dyadic perspective is not suitable to understand how value cocreation is enhanced or inhibited in this context, but a network perspective is needed to understand how actors are related to each other and interacting to cocreate value. The understanding of the actors' experiences involves four steps: mapping the value network, understanding actor's goals, understanding actor's journey and understanding actor's interactions.

4.1.1 Mapping the Value Network

To obtain a broad view of the network actors and their relationships, it was designed an actor network map (Figure 2) which represents, in a high-level and straightforward way, the actors involved in pressure ulcers care. The information gathered through the interviews allowed understanding that many institutions and many actors need to cocreate value to aim for a higher goal – the patients' well-being.

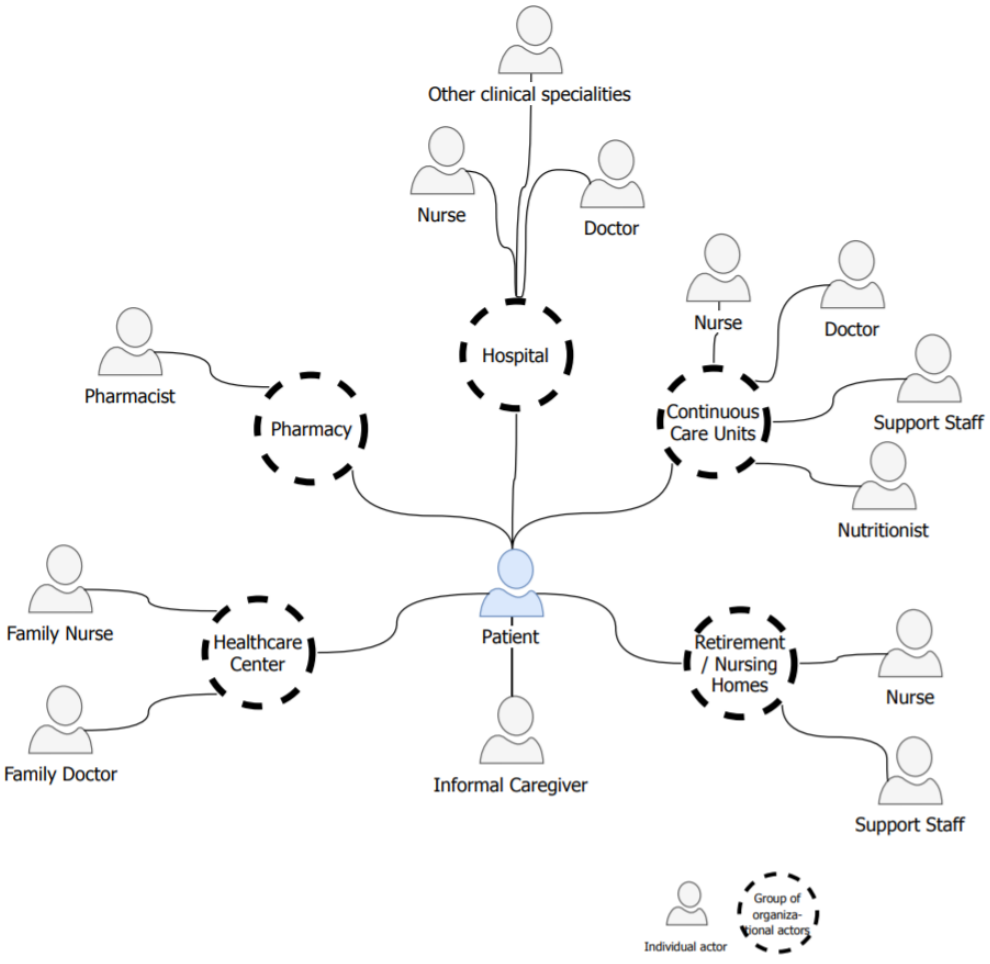


Figure 2 – Actor Network Map for Pressure Ulcers' Care

The diagram shows that many actors, with different specialties, from several organizations, are involved in pressure ulcers' care. Patients and their informal caregivers can interact with several health organizations and healthcare professionals, mostly with nurses. The actor network map evidences the complex value network of pressure ulcers' care and so, the need to study many actors in the service design to provide meaningful experiences, especially when the value is dependent on so many interactions.

To note that, although the point is to know as much as possible about the stakeholders in this clinical context, the perspective presented in this research can be more focused on continuous care and retirement home due to sampling constraints. Furthermore, it was possible to conclude from the interviews that, although specific clinical activities and standard guidelines are performed, different organizations can have different clinical and information procedures, as well as tools and resources, and so, testing and implementing a new service should take in consideration those specificities. The actors studied in this investigation are mostly related to continuous care unit, retirement homes, and pharmacies. Home care is not an organization per se, but a service which can be performed by several institutions represented on the map such as the healthcare center, continuous care units, and retirement homes.

4.1.2 Understanding Actors' Goals

This stage entails the analysis of the different actor goals and examines potential conflicts. Healthcare professionals, informal caregivers, and patients were consistent when asked to talk about their goals, depending on the situation, they are to prevent and to heal pressure ulcers and contribute to improving patient well-being (Figure 3). Naturally, these are immediate goals related to the healthcare practice, and so, they emerged quickly during interviews. Secondary goals were also identified which can impact the first ones, such as prevent infectious occurrences and ensure that preventive measures are performed. In fact, prevention is the key process to achieve the first goals, since the healing process is also based on preventive activities.

Figure 3 – Actors' Goals

4.1.3 Understanding Actors' Journey

The journey of an actor depicts the main activities of each different actor.

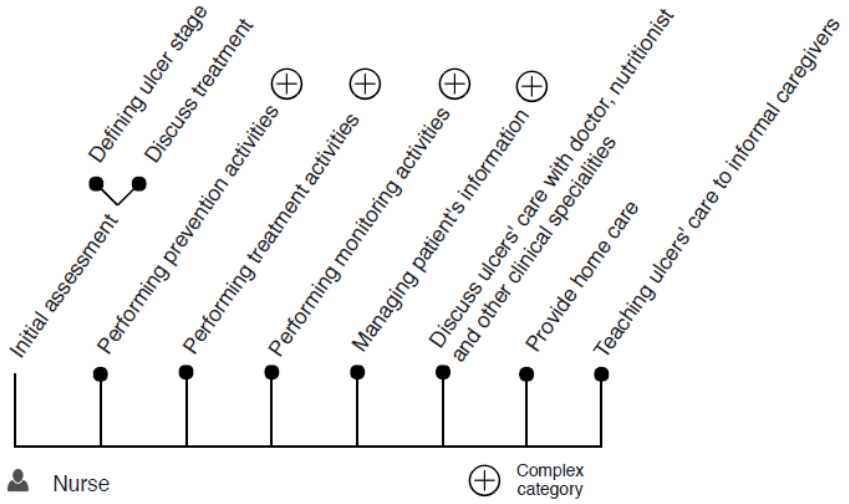


Figure 4 – Nurse Activities through Customer Journey

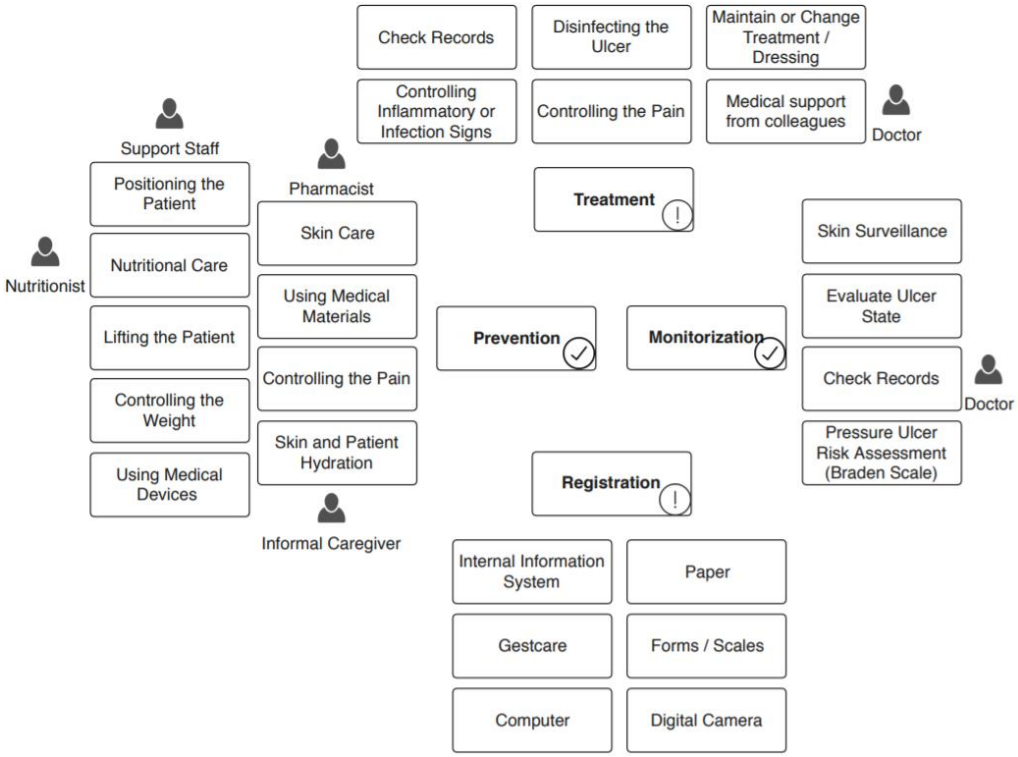


Figure 5 – Detailed Diagram with Nurses Activities

Nurses have the most prominent role in pressure ulcers' management, being involved in many activities as depicted in Figure 4 and Figure 5. One of the most significant challenges is to manage all the tasks and the time available to them. The importance of preventing pressure ulcers can't be overstated, since they consider that good care can result in good health, and they see it every day.

> [Due to] the prevention that we have, positioning the patient at the right time, our routines, I think we have good results (nurse, 31 years old).

In every clinical context, the prevention is always the best procedure. In this case, prevention is fundamental because, in most cases, ulcers can be avoided.

> Sometimes pressure ulcers develop, and we can't find the cause but, in most of the times, ninety percent of the times, is due to bad care (nurse, 31 years old).

The need to teach informal caregivers to be aware of the problem is crucial in this context since they lack information to know what to do when dealing with this condition.

> Work with the family member and teach them to be alert for signs… one simple rush or redness... they simply miss it (nurse, 30 years old).

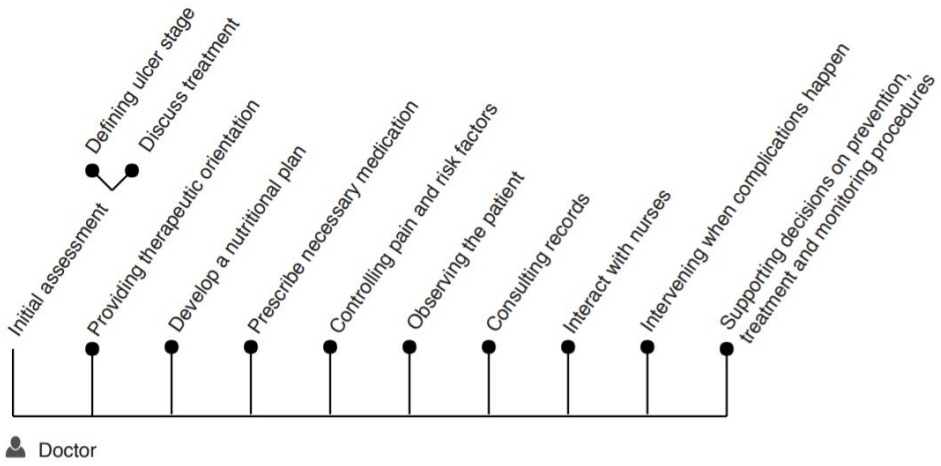


Figure 6 – Doctor Activities through Customer Journey

The role of doctors, from the continuous care unit perspective, is to support the nurse team in the decision to change or introduce new treatments and intervening when complications in treatment happen. One doctor pointed out that he observes the patients every day, although it is possible to monitor the patients' conditions through records.

> I occasionally intervene when complications in treatment happen (doctor, 34 years old).

Doctors allow nurses to be autonomous on the pressure ulcers' management and, concerning monitorization, they can see the patient, they can see the records, or have the nurse's feedback (Figure 6).

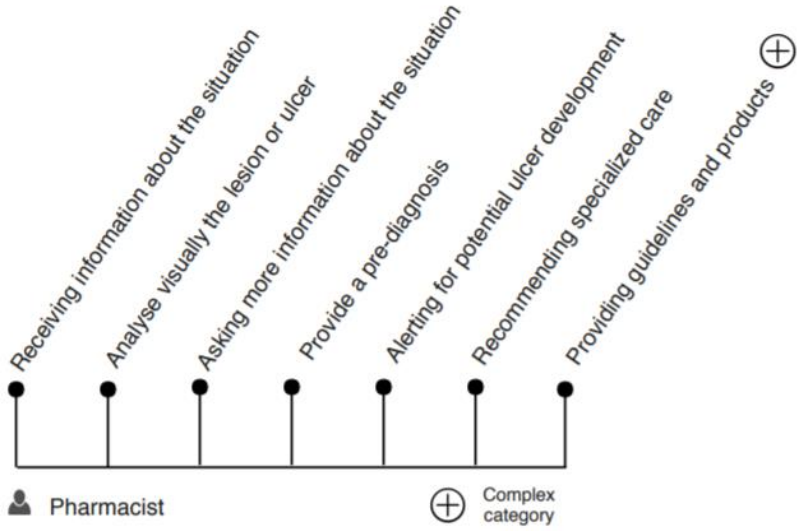


Figure 7 – Pharmacist Activities through Customer Journey

In this complex value network, the community pharmacists (Figure 7) engage mostly with citizens seeking more information about wounds, "tell me, please, what is this? I noticed this wound, what do you think it is?" Usually, the informal caregiver or a family member is the person who shows in the pharmacy and, more rarely, the patient himself.

When the ulcer is at an early stage, such as redness or a rush, the role of the pharmacist is to alert for the risk of pressure ulcer development underlying that lesion. They can help by providing a pre-diagnosis.

> Due to being in direct contact with the citizens, the community pharmacist turns out to be many times the first line of intervention (pharmacist, 31 years old).

The participants pointed out that their interventions are limited since they do not perform ulcer treatment or monitorization, it is a very complicated area, and thus, it requires some degree of specialization and many years of experience. Additionally, one nurse emphasized that ulcers treatment does not belong to the job functions or qualifications of any pharmacist, although receiving some training during academic education. Even so, the daily routine would never provide enough practical intervention to acquire the necessary experience to provide the appropriate care. According to the pharmacist, the nurse is the professional qualified to provide the best care related to pressure ulcers.

According to the pharmacists, people act only in late ulcer stages, not knowing that initial investments in the delicate skin can result in substantial financial savings and improved health. Being prevention a crucial process, there is the need to teach ulcers care to the citizens.

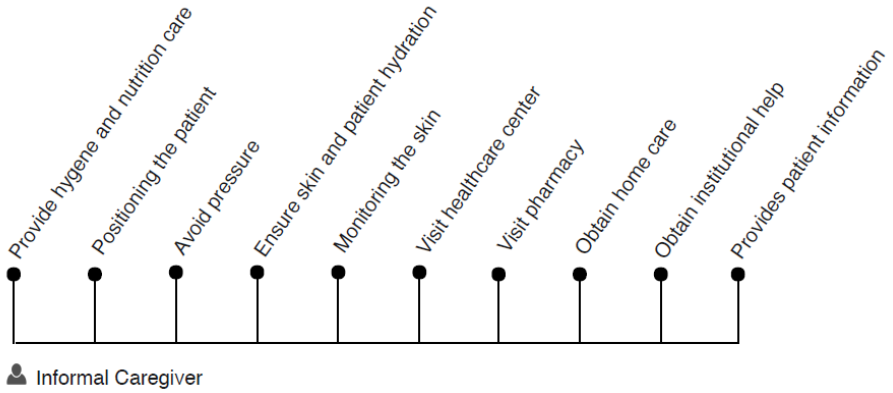


Figure 8 – Informal Caregiver Activities Through Customer Journey

The informal caregivers (Figure 8) have a tough role because pressure ulcers' patients require a lot of informal care, especially when they have reduced mobility and other pathologies, such as mental conditions, which make them entirely depended on someone.

> I'm the one who provides everything she needs (informal caregiver, 78 years old).

In this case, avoiding pressure ulcers is a fundamental goal of informal caregivers because not only contributes to a better quality of patient's health but reduces the possibility of complications regarding suffering and effort.

> Now [the goal] is to avoid more wounds (informal caregiver, 78 years old).

However, the awareness of that vital goal usually only emerges after they had to deal with this condition once. Many times, people only seek help when things get worse.

> I never had to deal with pressure ulcers before… In the beginning, I did not think it could be something serious, I thought it was a blister or a simple wound (informal caregiver, 51 years old).
>
> Unfortunately, when [people] seek help, they do it too late… the problem is that sometimes [the ulcer] is already in such advanced stage, we have to refer [the patient] to specialized care, we are no longer able to help them (pharmacist, 29 years old).
>
> Sometimes people ask for help only when [the ulcer] is already in a severe condition (nurse, 29 years old).

Healing is a long and hard process and, due to an advanced age, reduced mobility, neurological conditions, the process becomes even more complicated. The disorientation and confinement to a bed or a wheelchair makes the job of informal caregivers even harder, resulting in difficulty to continually prevent pressure and positioning the patient. The need to have more support is unquestionable; therefore, informal caregivers often resort to other actors or institutions to get additional help, such as retirement homes or independent home care. Additionally, since they do not have the necessary scientific knowledge to perform ulcers' treatment, they benefit from the help of the healthcare center to do it, especially with home care. They also visit the pharmacy when they need to get some products for skin hydration and pharmacists have the concern to know more about the situation and provide guidelines, such as orthopedic material.

The patient interviewed does not actively self-manage his condition, and so, his intervention and activities are limited. However, he always tried to know more about his treatment and did whatever it took to get better, such as avoiding sitting for long periods of time. It was a long and arduous process due to many complications, which forced him to interact with several health organizations and professionals, such as hospitals and continuous care units.

> I always tried to do what nurses and doctors told me to, so everything would turn out for the best (patient, 49 years old).

4.1.4 Understanding Actors' Interactions

Having analyzed the activities performed by each actor, the next step examines the interactions among them to understand how resources are integrated to cocreate value. Figure 9 exemplifies the complex set of many-to-many interactions involved in pressure ulcers' care and the information exchanged between healthcare professionals and health institutions. The example is based on the experience of the patient interviewed when dealing with a pressure ulcer.

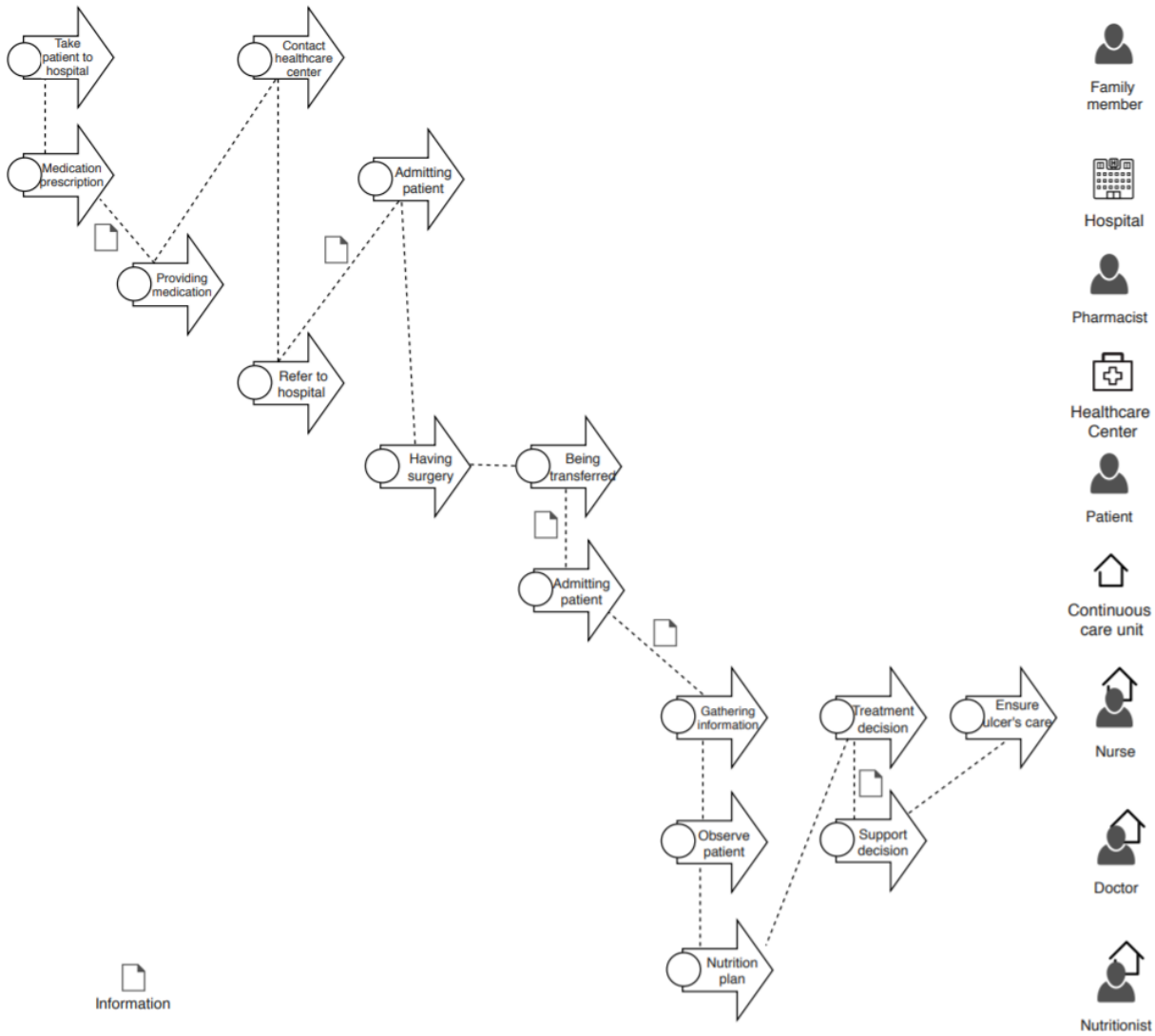


Figure 9 – Example of Multiactor Activities and Interactions

The patient is the principal beneficiary of the healthcare services because he/she depends on healthcare professionals to be assisted and treated. In this case, the patient has 49 years, and he has paraplegia, which means that he has reduced mobility. When his overall health got affected (fever), he was forced to stay in bed for days which caused the ulcers to develop. When things got worse, a family member took him to the hospital where he was prescribed with medication and sent home. In the meantime, his conditions would not get better, so the

family member had to call to the family doctor, from the healthcare center, who came home, examined him and sent him again to the hospital with a letter. He got admitted to the hospital and had surgery. To recover from the surgery and to heal his ulcers, he was sent to a continuous care unit. This example shows how pressure ulcers' care involves many actors and the information needed by each one to provide the adequate treatment.

The nature of pressure ulcers' care is highly dynamic, and interactions can occur in numerous ways (e.g., the patient can go directly to the healthcare center, hospital, continuous care unit or retirement home), therefore, mapping all the possibilities would be challenging, and it is not the point here. Nevertheless, data analysis allowed identifying more permanent interactions within pressure ulcers' care (Figure 10). The perspective presented here is focused on continuous care units and retirement homes, as such, depending on the institution, one actor can have more influence than the one represented here.

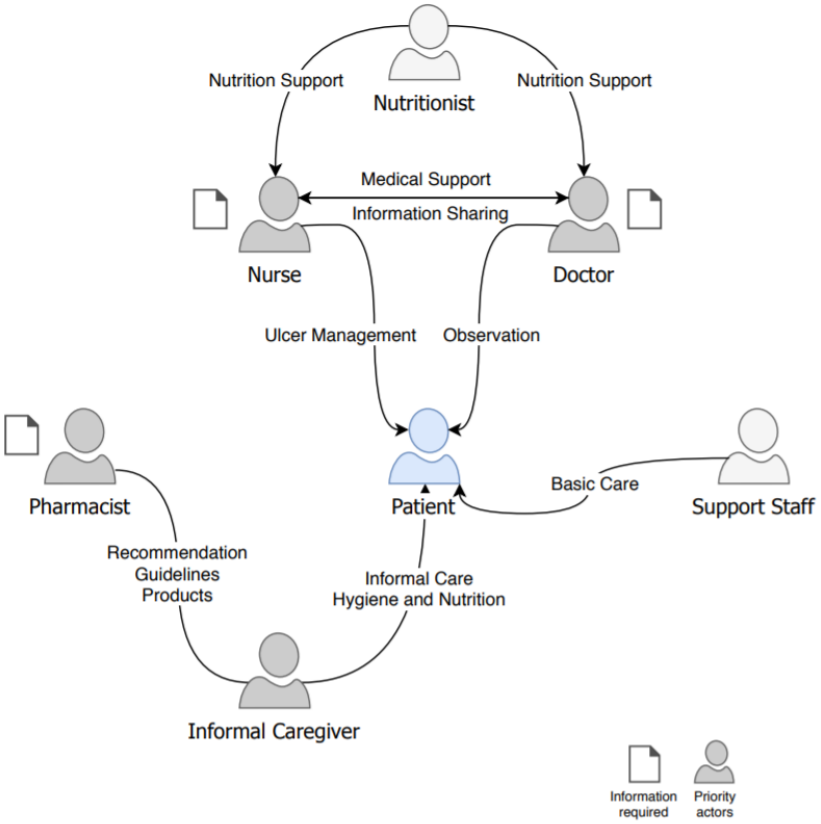


Figure 10 – Multiactor Interactions

Although sharing some activities, the levels of interaction in this value network are different since each actor has his role in pressure ulcers' care. The nurse is the main responsible for the ulcer management; the doctor intervenes mostly when complications in treatment happen, and in the decision of lifting or positioning the patient and to change or introduce new treatments; the informal caregiver provides what the patient needs in terms of hygiene and nutrition care; the pharmacist alerts for potential ulcer development and provides guidelines, recommendations, and products to avoid pressure ulcers and maintain the patient's health.

4.2 Health Information Management

The understanding of the actors' experiences also enabled the identification of health information needs that are crucial to design a service aiming to improve actors' experience. The relevance of this subsection is related to the research objectives and became even more evident as the interviews occurred, not only because participants were asked to talk about it, but mostly due to health records being a recurring subject regarding issues and improvements.

Health records are essential to provide the best possible care since it leads the healthcare professional to plan and develop the adequate treatment for a specific patient with a specific clinical condition. Since the quality of the records influences the quality of healthcare, accurate and systematic documentation procedures should take place to ensure the quick and easy access to content.

Healing an ulcer is a long process that requires intervention every two or three days, depending on the ulcer stage, and every intervention needs to be documented along with ulcer's characteristics. Additionally, every time that treatment is necessary, healthcare professionals must have access to previous information to assess the treatment effectiveness and change it if needed, since ulcer characteristics influence the treatment process.

> [To register] either at diagnosis and in every follow-up evaluation after (doctor, 34 years old).

In this case, health records are vital to provide a holistic view of the patient's condition and ulcer status and support the medical decision of choosing the best possible treatment. Understanding the healing process evolution can be done only through records. Moreover, organizations have nurses working by shifts, and each one requires the information about the previous wound treatment.

> Imagine that the nurse who did the treatment in the morning is not the one who is in the afternoon and needs some information, at any time we can access the records and see (nurse, 30 years old).

The healthcare professional responsible for production and management of health records is the nurse, who is clearly more engaged in the ulcer management.

> [We have] nursing feedback because they register everything (doctor, 63 years old).

Documenting care usually happens at the end of the shift, when the hygiene care, prevention activities, and the necessary treatments are done. That task imposes some challenges for the nurse because it requires an excellent photographic memory, otherwise, information is lost.

> For instance, the shift starts at 9 a.m. with hygiene care and pressure ulcers' treatments, I will only register around 1 p.m., which means, if I do not have a photographic record of the wound, my memory will probably not… we are tired, and we ask ourselves "what did I see?" (nurse, 31 years old).

> He [nurse] can forget and so can I [doctor]. If one register, one does not lose the information (doctor, 63 years old).

Different organizations manage wounds in multiple ways and have various resources to register and access to information, as electronic health records, paper or both. In case of the

participants interviewed, their organizations have several places to register digitally (through a computer) and manually (through paper folders). Because the registration process is not optimized, each resource attempts to disseminate the information, for instance, having a piece of paper with last treatments and the next date of intervention.

> We have a folder in which we schedule the ulcers' treatment containing the last treatment applied and the date for the next since would be very difficult for us to open the program and check, patient by patient, if there is a treatment schedule for that day. That was internally settled to quickly ensure the continuity of information (nurse, 31 years old).

Moreover, apart from if done in paper or through a computer, documenting wound care forces the healthcare professional to sit in his/her office and spend time trying to remember and figure what to write in the most accurate possible way, after seeing several patients and multiple wounds. Additionally, this system is not able to support the everyday clinical practice of nursing since access to patient's history is not bedside accessible, which is the place where it is most needed.

> [To have] more facilitated access and simultaneously with the registration, so we can have a better perception, at least covering the last treatment (nurse, 31 years old).

The problem with health records relies, not on the information itself, but the way people register and access to it. The following table exemplifies the relevant information needed in pressure ulcers' care:

Patient Information	***Ulcer Characteristics***
Age	Category
Clinical history	Size (Length, Height, Width)
Patient mental condition	Depth
Patient autonomy	Location
Patient lifestyle	Exudate (quantity, type)
	Surrounding tissues and color
	Wound tissue type (granulation, necrosis, fibrin) and quantity
	Pain
	Smell
	Treatment (frequency and type/dressings)

Table 5 – Relevant Information for Pressure Ulcers' Care

Participants find both text and image important because, on one hand image is not capable of characterize some ulcer aspects, such as the smell or the exudate, since the photograph is

taken after the ulcer is cleaned, on the other hand, image provides a quick and visual way to understand if the ulcer is healing or aggravating.

> The information is complete, the only thing missing is the visual help to be even more complete (nurse, 29 years old).

> The ideal would be to always have a photograph along with the record because it would allow seeing a continued evolution (doctor, 34 years old).

> For a pressure ulcer patient at home, if it is treated on a Friday and after a few days, the photographic record would be useful (doctor, 63 years old).

Although the image is a fundamental component, the process of capturing and store it is not optimized, which causes the nurse to waste valuable time on registration.

> If we take a photograph with our smartphones, we need to send it to the institution's email, we download it, and we save it in a separate folder; if we take a photograph with the digital camera, we need to grab the cables, we transfer the image to the computer and we store the image on a separate folder (nurses and doctors).

> It takes a lot of time and so, right now, we do not see the benefit on the photographic record because we prioritize care and we register [text], so we do not lose information and the colleague doing next shift can know the ulcers' state and its evolution (nurse, 27 years old).

> We lose about twenty to twenty-five percent of our time in registration, time that could be dedicated to more 'practical' care (nurse, 30 years old).

Healthcare professionals raised concerns regarding the quality of clinical photography, since the point of using it is to provide better clinical judgment. Poor image quality only handicaps the process of determining and choose the appropriate dressing according to the records. The fact that the digital camera wasn't always available, either due to low battery or being used by other services, make the process difficult and slow.

> I see many good-quality photographs, and you can see the ulcer's status, with a less good-quality picture you can't… (nurse, 29 years old).

> Initially we used to take wound photographs, but eventually, we stopped… you can't photograph a wound in an unsystematic way… and different people are photographing… the image did not always correspond to the reality, so we stopped making photographic records, and we based our care only on the written records (nurse, 29 years old).

A critical aspect of clinical photography is the privacy of the patient, and so, healthcare professionals ask consent before capturing the image.

> [To photograph the ulcer] I always ask the patient's consent, if he/she is not capable of understanding then I ask the family (nurse, 25 years old).

For communication purposes, nurses usually talk with each other during or between shifts to alert for situations that need immediate intervention, or through a mobile phone, to ensure that information is transferred from professional to professional. To overcome the information management challenges, some nurses created a WhatsApp group to share photographs and exchange information.

> We communicate, through a mobile phone, to share what has been done and what should be done next (nurse, 25 years old).

> In the hospital where I also work, since we are a relatively small team, ten nurses, we created a group chat in WhatsApp and, every time we perform ulcers' treatment, we try to photograph the ulcer and share it in the group, so everyone can have an idea of the ulcer's status. Afterwards, the nurse who is doing the next treatment can compare with the photograph taken and understand if the ulcer has evolved or deteriorated (…) nowadays, the internet is available to everyone, and everyone has a smartphone or mobile phone capable of capturing images, with a good photographic capacity and, for us, it is a valuable information source (nurse, 24 years old).

The solution should find the balance between preciseness and flexibleness, to allow the accuracy and consistency of information among different personal perceptions from different nurses, but at the same time to not limit the information that can be shared through records.

> [Records] to have list selections, but also to have the possibility if necessary to register observations (nurse, 24 years old).

Participants not only identified the biggest challenges related to documenting care, but also were very enthusiastic in providing suggestions to overcome them. In health institutions were professionals did not register ulcers' images, it was suggested to start taking pictures regularly and systematically. To do so, the image storage must be improved, and its acquisition should be as automated as possible. The participants envisioned a new mobile solution which could allow the registration and access in real time, detect ulcer size, ensure preciseness and flexibility of information, display diagrams based on the input, have different evaluations to different frequency assessments, and to be integrated with other information systems already in place such as GestCare[6]. Note the following comments:

> Allow us to register in real-time, with the ulcers' image, with access to the exudate's data, that would be much more practical and with a small device that was not the computer, something simpler and faster (nurse, 30 years old).

> If we had a smartphone or tablet with us all the time, it would be perfect, it would be the best thing, because sometimes you know the treatment you need to perform in that specific ulcer, but you get there, and it has a complete different aspect you were not expecting (…) register in real-time, just one minute and we did not lose information (nurse, 30 years old).

> If we had an app it would be beneficial because we might even discuss more easily… if we had an app and we could all talk at the same time about a specific situation, at some point we would not need to have several nurses speaking with each other trying to share the same information when changing shifts, for instance (…) maybe it would also facilitate the photographic record since it would not require for us to go and ask for the digital camera, take the memory card and place it on the computer… (nurse, 27 years old).

[6] Information system developed by the National Network of Integrated Continuous Care to register and monitor healthcare, namely the pressure ulcers' care.

> [A solution] that would show us a graph, so we could see in a visual way the ulcers' evolution based on the characteristics already registered (nurse, 32 years old).

Regarding health information management in view of the remining actors, the registration and access to information is rather different. Community pharmacists do not have in place any procedure that involves this type of registration, therefore, they do not register wound or patient information. Pharmacists do require some information from the citizen to intervene as much as possible considering their role. Usually, the citizen starts by explaining the situation and provides a wound description containing the location, duration, and cause of the pressure ulcer. Sometimes patients show the ulcer and, occasionally, informal caregivers bring an ulcer's image. When the information provided by the citizen (i.e., patient or informal caregiver) is not enough, the community pharmacists ask more questions to have a better perception of the situation, but in general, citizens can provide the information pharmacists need to act. To have a more informed decision, the community pharmacists need to know the duration of the symptoms, its location and color, if the patient is experiencing pain, if the ulcer is infected, presents exudate or is bleeding, other health issues, patient's history, mobility and nutrition, and what has been done.

Regarding visual reference, it is essential to check the lesion appearance because sometimes citizens are not aware of or minimize the severity of the problem. Having the caregiver present is better to see the wound photograph, having the patient present is better to see the wound. Sometimes, citizens do not want to show and have right to do so. Still, they consider the image a fundamental resource and recommend the citizen to take photographs of his ulcer to bring them for medical appointments, so the doctors or nurses in healthcare center, for instance, have a better timeline of the ulcers' evolution. In case of regular citizens who visit the community pharmacy with some periodicity, they have access to some personal information such as contacts and addresses, exceptional cases of some monitorization was done through phone calls (to understand how things were going). In some critical situations, a nurse mentioned she already had to intervene and called directly to the doctor or healthcare center, since they have access to some information, such as the name of the doctor or the healthcare center, due to digital prescriptions.

Different health specialties are needed to provide a more complete care to pressure ulcers' patients, therefore, there is the need for different organizations and actors to collaborate and to cooperate. That collaboration involves resource sharing since the citizens' health information is needed by the different actors to deliver the best care.

> Developing multidisciplinary teams, involving the doctor, the nurse and the community pharmacist, and would make sense that between these three professionals information would flow between them for the benefit of the patient (…) [to have] a conductive thread between the three professionals or areas that would allow the timely prevention of a patient, many times, it is a matter of prevention (pharmacist).

For that same reason – different actors, different information, and different treatments – it is important to have a consistent follow-up procedure to provide the same care regardless of the professionals that are performing it.

Importance to have a consistent and coherent follow-up procedure of a specific pressure ulcer and the patient himself that did not change according to the professional providing the care on a daily basis, to have a record containing the medical evaluation and what is needed to evolve positively and when to be reevaluated

> [To have a record] it is like a medical prescription, a person has tonsillitis and needs to take an antibiotic or an anti-inflammatory. To have a prescription of the treatment to be done and to be followed by every nurse who will treat it, before being re-evaluated by the doctor, I think that would be very important to help the patient (nurse).

When asked about health information, informal caregivers replied that they do not register information about ulcers either take photographs. One participant mentioned that some family nurses, who used to provide home care, sometimes took photographs for ulcer's evolution comparison and share them with her, but any significance was pointed out concerning the image. Even so, they demonstrated to be conscious about the importance of registration to support healthcare.

> Maybe that way there was a strict control of the ulcer status [informal caregiver, 51 years old].

> When things are registered, we understand better what happened and when, right? [informal caregiver, 78 years old].

The patient always tries to know more about his treatments by asking questions to healthcare professionals, especially nurses since they are the main point of contact for pressure ulcers' care. Even though he does not register information about himself neither photographs his ulcers, he considers the image and registration important, and keeps some of the images taken by the nurses to himself.

> I always tried to know what type of dressings [nurses] used (patient, 49 years old).

This chapter provides the necessary understanding to set in motion the next stage of service design – ideation – to design an innovate technology-based service which addresses the needs and suggestions of the participants and improves the value cocreation and patient well-being. The next section contains a discussion of new insights into the main findings.

5 Recommendations for a New Service

This section addresses the research objective, which is to understand how ICT can improve the pressure ulcers' care and adds findings to the studies reviewed in the literature (e.g., Santos (2011), Rodrigues et al. (2013), Parmanto et al. (2015), Friesen et al. (2016) and Salomé & Ferreira (2018)). Understanding how ICT affects the different actors involved is important to address the challenges of managing pressure ulcers' care and foster value cocreation.

The purpose of understanding the customer experience is to explore new service possibilities and design a practical solution based on the needs identified. In this case, several needs and pain points were pointed out related to the overall care, such as the need to empower patients and informal caregivers to prevent and monitor skin lesions; the expected complications in the treatment process depending on the patient and ulcer conditions and the material available to provide the adequate treatment.

Study results emphasized a significant pain point, common to several healthcare professionals, which is related to the management of health records. To enable new forms of value cocreation, a new solution is needed to facilitate the information flow among healthcare professionals in the most automated way. As reviewed in the literature section, mobile information and communication technologies are incredibly appropriate to ensure the real-time, anytime, anywhere access and registration, regardless of the healthcare professional who is delivering care. Therefore, informed medical decisions are empowered, and treatment resources are better employed. In healthcare, time and knowledge are powerful resources, therefore, any process or service innovation related to information can add significant health outcomes.

As mentioned in the results, mobile solutions are viewed as a beneficial tool for healthcare professionals to save time in manage records and concentrate their valuable knowledge on 'practical' care (e.g., prevention is the key process to achieve the goal of preventing pressure ulcers and so, the focus of health actors should be placed directly on the patient). Accordingly, it is relevant to point out a few general implications about ICT for this complex healthcare setting to enhance value cocreation.

Firstly, the use of smartphones for ICT solutions is convenient in a way that people have it with them full-time, and it is a lightweight tool to register information, capture and transfer images quickly and automatically. Table 6 provides some suggestions regarding the use of ICT to improve health information management.

Category	*Definition*	*Outcome*
Access	Access previous treatment and patient's history to decide on the next procedure;	Better clinical decision
	Daily to-do list so nurses can quickly know what patient needs treatment and what type of treatment;	Better clinical intervention
	Different professionals doing different shifts to have the same information;	Better clinical decision

Register	Assess wound characteristics and simultaneously register the information in real time;	Information completeness
	Include all the descriptive data mentioned in the results as well as scales for pressure ulcer risk assessment, such as the Braden Scale;	Information completeness
	Standardize wound terminology, so every record entry is perceptible and understood by every professional;	Better clinical collaboration
	Incorporate different registration moments and set reminders and notifications to ensure they are performed;	Better clinical intervention
Image	Capture ulcer image and automatically store it in the right place;	Effort and time saving
	Track wound status and evolution through images and/or charts using data input;	Better clinical intervention
Share	Communicate by notes, chats, warnings or alerts;	Better clinical collaboration
	Easily share information with nurse colleagues and ask for clinical advice or discuss with the doctor new procedures;	Better clinical collaboration
	Integration with other health information systems that are already in place in institutions;	Effort and time saving

Table 6 – Suggestions for ICT usage

To note that, during the study, it was clear the need to standardize and provide guidelines for image acquisition, since it becomes less desirable if not appropriately captured and within a minimum quality range.

To evidence usefulness of a mobile ICT for health record management, a high-level service blueprint was mapped to illustrate a potential ‘to be’ process of documenting pressure ulcers’ care (Figure 11). The map shows that touchpoints have been reduced (computer, paper, gestcare > smartphone), tasks have been removed (image manually transfer), information is transferred automatically and synchronized, duplication of data is eliminated, and time is improved. The overall experience of healthcare professionals can be improved if the relevant touchpoints for service delivery are introduced, or weak touchpoints are removed, according to user needs (Stickdorn et al. 2011). The use of ICTs by healthcare professionals, especially nurses, can impact their practice, not only in terms of providing good care but also in terms of effort saving.

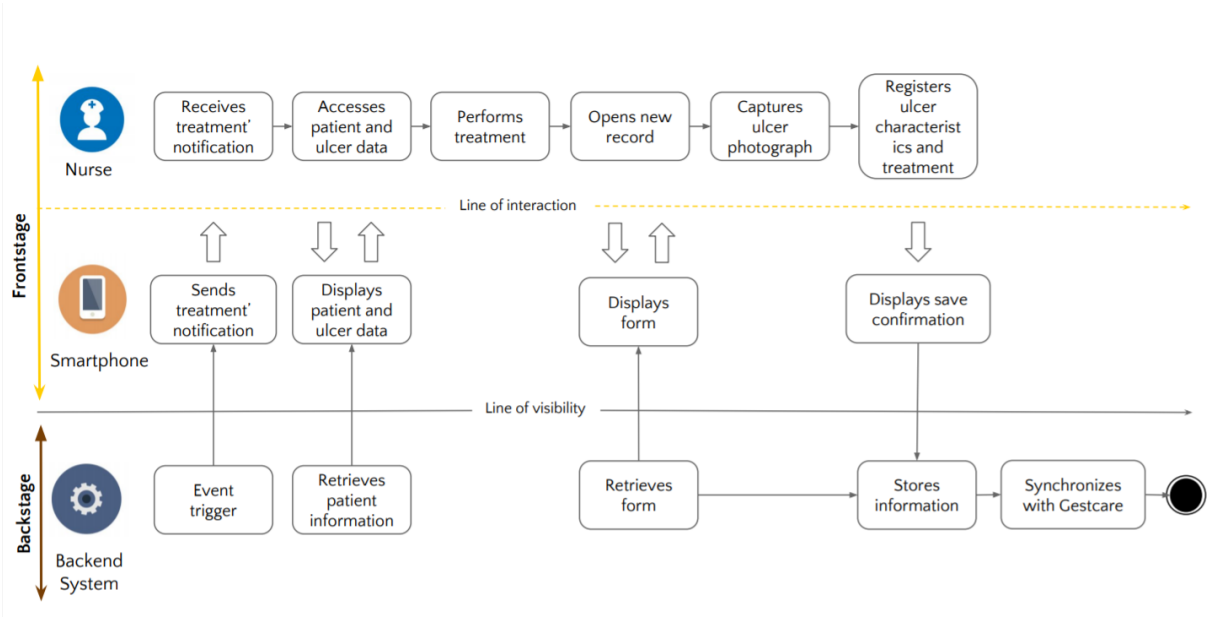


Figure 11 – Service Experience Blueprint for Documenting Pressure Ulcers' Care

6 Conclusion and Future Research

This research contributes to further understand customer experience and value cocreation for improved well-being and the dynamics of multiple actors' interactions within a complex value network (Ostrom et al. 2015) such as healthcare. As technologies are leveraging value cocreation activities in a complex value network, the study focused not only on people and organizations but also on shared information and technology (Maglio et al. 2009) and how it can advance health services. The service design approach contemplated holistically the actors and their interactions which influence the overall experience or service (Holmlid & Evenson 2008; Mager 2009). A network perspective is needed for complex systems since the analysis of multiple interactions provides valuable insights for designing services which enhance value cocreation through resource integration. As such, the study adopted the SD4VN approach developed by Patrício, Pinho, et al. (2018), which studies the customer experience in value networks.

Going back to the research question, *what are the experiences of pressure ulcers' actors and how do they cocreate value?* The investigation identified a list of value cocreation activities both in isolation and interconnected aiming to achieve a common outcome – patient well-being – and demonstrated that different actors have different roles and levels of interaction. In fact, some actors engage more in value cocreation activities and collaborate more with other individuals than others.

The study of customer experience and service design, especially in healthcare, is quite focused on the customer. However, in pressure ulcers' care, the patient frequently has a condition that hampers an active self-management of his/her health. Such dependency shows the importance of having a broader, network understanding of the customer experience, not focused only on the immediate customer, but in all actors around him who can influence and provide a better experience. The service design effort should be instead on the caregivers, especially the healthcare professionals so that they can provide better care to the patient through value cocreation.

Study results also enabled the identification of improvements for the management of health information for pressure ulcers. To improve the experience of healthcare professionals, the findings suggest the need to enhance value cocreation by streamlining and systematizing the process of documenting care, as discussed in the last chapter. It was highlighted the need to have a mobile solution that allows healthcare professionals to manage health records better, support clinical decisions and, consequently, provide excellent care. Mobile health can assist the real-time access and registration, saving the time and efforts that can be redirected to 'practical' care. One pain point of documenting care already mentioned is the clinical photography, considered an extremely important component, which can be renounced if its management delays care delivery or do not achieve the quality needed to support clinical judgment.

If resources are integrated (e.g., information, clinical support, scientific knowledge), and actors collaborate to cocreate value (e.g., empower caregivers with knowledge to act as early as possible; involve the pharmacist on the prevention process), the customer experience is

enhanced, and the patients' well-being is improved. This health context clearly shows the need to explore and ideate services not only for the customers, but for the value network.

Future Research

The results obtained from this study are currently being used to provide the necessary understanding to proceed with the subsequent process of service design – ideation – and assist the development of a new technology-based service related with mHealth to support healthcare professionals and promote the overall effectiveness of pressure ulcers' care. The main goals of the solution are to provide a meaningful experience to healthcare professionals, improve healthcare outcomes, enhance patients' quality of life and reduce the costs and suffering associated with this medical condition.

Limited access to patients and informal caregivers did not provide enough evidence on how and to what extent they can cocreate value using technology to register information and capturing ulcer images. Due to the ubiquity of mobile devices, patients and informal caregivers can take photos of ulcers and share them with the healthcare professionals, contributing to better health management and precise control of the healing progress, not to mention saving time and resources involved in a face-to-face medical appointment. Future research should investigate the role of technology among pressure ulcers' patients and their informal caregivers to cocreate value by self-management this condition.

As seen on the actor network map, other relevant actors are engaged in the pressure ulcers' care. Therefore, further research should study the experience of the healthcare center for instance, since it plays a crucial role in the citizens' health.

The information gathered from the interviews does not deepen on how information is exchanged between organizations, and so, future investigation should focus on understanding how health organizations cocreate value among them.

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Appendix A: Participants Socio-Demographic Information

- Healthcare Professionals

Age	Gender	Occupation	Specialization	Professional Experience	Smartphone	Internet
36	Female	Pharmacist	Not Applicable	12	No	Yes
29	Female	Pharmacist	Not Applicable	6	Yes	Yes
31	Female	Pharmacist	Not Applicable	9	Yes	Yes
45	Female	Nurse	Tissue Viability Master	25	Yes	Yes
24	Male	Nurse	Emergency, Trauma and Catastrophe	2	Yes	Yes
25	Female	Nurse	General Nurse Care	3	Yes	Yes
79	Female	Nurse	Public Health	42	Yes	Yes
30	Female	Nurse	Rehabilitation Nursing	7	Yes	Yes
31	Female	Nurse	General Nurse Care	7	Yes	Yes
32	Female	Nurse	Community Health	7	Yes	Yes
31	Female	Nurse	General Nurse Care	7	Yes	Yes
30	Male	Nurse	Rehabilitation Nursing	7	Yes	Yes
30	Female	Nurse	General Nurse Care	7	Yes	Yes
34	Male	Doctor	Internal Medicine	9	Yes	Yes
27	Female	Nurse	General Nurse Care	6	Yes	Yes
29	Female	Nurse	Rehabilitation Nursing	7	Yes	Yes
30	Female	Nurse	General Nurse Care	9	Yes	Yes
25	Female	Nurse	General Nurse Care	4	Yes	Yes
29	Female	Nurse	General Nurse Care	5	Yes	Yes
63	Male	Doctor	Family and General Medicine	38	Yes	Yes

- Informal Caregivers

Age	Gender	Education Level	Occupation	Smartphone	Internet
51	Female	4 Grade	Housekeeper	Yes	Yes
78	Male	4 Grade	Retired	No	No
93	Female	Unassigned	Retired	No	No
56	Female	9 Grade	Unemployed	Yes	Yes

- Patient

Age	Gender	Education Level	Occupation	Smartphone	Internet
49	Male	4Grade	Retired	Yes	Yes

Appendix B: Interview

Healthcare Professional

1. Age
2. Gender
3. Occupation, professional experience and specialization?
4. Do you own a smartphone? If so, do you use internet on your smartphone?
5. Tell me about your experience in pressure ulcers' care.
6. What are the main goals of pressure ulcers' care?
7. What activities do you perform in the prevention, treatment and monitorization processes?
8. What means and tools do you use in the prevention, treatment and monitorization processes (services/ information systems/ equipment...)?
9. To what extent those services support you in your activities and satisfy your needs?
10. What are the main challenges you face in the prevention, treatment and monitorization of pressure ulcers?
11. Normally, with whom do you interact in these processes?
12. What data/ information are relevant in the pressure ulcers' care (text, image, …)?
13. How do you register and share that information?
14. Do you consider that the current process of registration and documentation of information related to pressure ulcers' care is optimized? Why?
15. Do you have any additional information or suggestion that you consider relevant to add to the study?

Patient

1. Age?
2. Gender?
3. Education level and occupation?
4. Do you own a smartphone? If so, do you use internet on your smartphone?
5. Tell me about your experience in pressure ulcers' care.
6. What are the main goals of pressure ulcers' care?
7. What activities do you perform in the prevention, treatment and monitorization processes?
8. Do you use any service (home care, institution, technology) to assist you in the prevention/ treatment of pressure ulcers?
9. To what extent those services support you in your activities and satisfy your needs?

10. What are the main challenges you face in the prevention, treatment and monitorization of pressure ulcers?
11. Normally, with whom do you interact in these processes?
12. Do you register any type of information (text, image, …) related to your pressure ulcers' care? If so, what and how? Do you share that information with anyone?
13. Do you consider to be important to have an information record related to pressure ulcers and its care?
14. Do you have any additional information or suggestion that you consider relevant to add to the study?

Informal Caregiver

1. Age?
2. Gender?
3. Education level and occupation?
4. Do you own a smartphone? If so, do you use internet on your smartphone?
5. Tell me about your experience in pressure ulcers' care.
6. As informal caregiver, what is your role and main goals of pressure ulcers' care??
7. What activities do you perform in the prevention, treatment and monitorization processes?
8. Do you use any service (home care, institution, technology) to assist you in the prevention/ treatment of pressure ulcers?
9. To what extent those services support you in your activities and satisfy your needs?
10. What are the main challenges you face in the prevention, treatment and monitorization of pressure ulcers?
11. Normally, with whom do you interact in these processes?
12. As informal caregiver, do you register any type of information (text, image, …) related to your pressure ulcers' care? If so, what and how? Do you share that information with anyone?
13. Do you consider to be important to have an information record related to pressure ulcers and its care?
14. Do you have any additional information or suggestion that you consider relevant to add to the study?