LUMEN ET VIRTUS

BLOOD PRESSURE DETERMINATION BRACELET FOR HYPERTENSIVE PREGNANT WOMEN: A HEALTH INNOVATION

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ABSTRACT

Objective: to report the experience of nurse researchers in the planning of a bracelet to determine the blood pressure of hypertensive pregnant women by means of photoplethysmography, with real-time monitoring of the pregnant woman. Method: this is an experience report that seeks to describe the conception of an innovative technological product in the health area developed by nurses. For the development of the product, design thinking strategies were used, in four main phases: immersion, ideation, prototyping and development. Results: the project is currently incubated at the Tecnosinos technology park, in São Leopoldo/RS, with a patent registration entry at the National Institute of Intellectual Property and with the first minimum viable product completed. Final considerations: the development of new technologies involves the following of strategic methods for innovation. This is an innovative practice, with the potential to contribute to the prevention of complications resulting from pregnancy.

Keywords: Innovation. Pregnancy-Induced Hypertension. Pregnancy Complications. Blood Pressure Determination. Nursing Care.

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INTRODUCTION

Systemic arterial hypertension is characterized by an increase in systolic and diastolic pressure, that is, when the systolic pressure is equal to or above 140mmHg and the diastolic pressure is equal to or greater than 90mmHg. Such a pathological situation can affect from children to adults, and is also a problem for women in the gestation period.(1)

Pregnancy implies several changes in the woman's body, generated by physiological and psychological issues that go through until the puerperal period.(2)

Prenatal care is essential for monitoring the mother and baby, avoiding or anticipating complications, such as hypertensive syndrome, considered one of the main causes of maternal-fetal death in Brazil and in the world, responsible for causing several complications in both the pregnant woman and the fetus.(3.4)

Hypertensive syndrome can compromise the renal and cardiovascular systems of pregnant women, and can also favor the occurrence of hemorrhages. In the fetus, it can lead to growth restriction, fetal distress and even death in more severe cases. Thus, in the gestational period, elevations in blood pressure levels without elimination of albumin in the urine require systematic monitoring of the mother and baby, with the need for rapid interventions aimed at stabilizing blood pressure levels for the continuity of a safe and healthy pregnancy.(3.4)

In the health area, several technologies have been used for both the diagnosis and treatment of diseases. In this context, the use of *wearables* for the continuous and intensive monitoring of patients at risk could enable a more agile and unique service, allowing remote and quick access to the patient's history, in order to guide or intervene, thus contributing to the reduction of complications and deaths.(5.6)

Wearables are wearable devices, that is, the user wears the device on their own body, such as a belt, a bracelet or other. In this way, user information is collected, such as vital signs, caloric expenditure, use of calling and messaging applications, among others. All information collected is stored, and may reach health services or even be shared with health professionals in other services, taking into account privacy policies.

Examples of *wearables* include smart watches, glasses, bracelets, and monitoring *patches* (which are like tattoos). Such devices allow the monitoring and storage of data on daily activities, exercises, sleep and many other possibilities. One of the main features is the real-time sending of data related to the functions of these devices.(7)

An example of this is photoplethysmography (PPG), a technique that makes it possible to monitor changes in volume and blood flow through an optical barrier and easily

found in pulse oximeters. The device detects these parameters when it generates a light-emitting diode (LED) illumination on the skin; it then measures the amount of light received with the aid of a photodiode (PD). Therefore, with each cardiac cycle performed, the peak of a signal that can be measured is provided.[8]

In view of this scenario, the present study aimed to report the experience of nurse researchers in the planning of a bracelet for the determination of blood pressure in hypertensive pregnant women by means of PPG, with real-time monitoring of the pregnant woman.

METHOD

This is an experience report that seeks to describe the ideation of an innovative technological product in the health area developed by nurses. The project for the new technology was developed during the discipline of Technologies for Health Care and Nursing, in the second semester of 2021, in the Professional Master's Degree in Nursing at the University of Vale do Rio dos Sinos (Unisinos).

Regarding the ethical and legal aspects of the research, the present work is configured as an experience report, not using data or personal information of any individual, only describing the process of developing a technological product for the health area. This was followed by legislation pertaining to copyright.[9]

For the conception of the product, *design thinking* strategies were used, which is a way of imagining future states through *design*, generating real products, services and experiences. It is understood that *design thinking* enables new paths for innovation. It is a method that addresses a holistic vision, focused on the human being, and that works with multidisciplinary teams, creating thoughts and processes that lead to innovative solutions for business. The *design thinking* process goes through four main phases: immersion, ideation, prototyping, and development.[10]

a) Immersion phase: initial identification of the problem, the needs of the actors involved in the project and possible opportunities for the construction of solutions. It is proceeded in a preliminary and in-depth manner. In the preliminary immersion phase, the master's nurses of the Graduate Program in Nursing met to approach the problem raised in the case of hypertensive syndromes in pregnant women, the search for identification of the needs of hypertensive pregnant women, the search for information on the epidemiology, prevalence and incidence of cases, and, finally, the search in databases to identify

guidelines, articles and case studies that would make it possible to understand the problem addressed.[10.11]

b) Ideation phase: after immersion, the product was conceived by collecting ideas to solve the problem (pain) through *brainstorming*, which is the technique for raising ideas and developing creative potentials. A matrix of alignment of ideas was then elaborated, in order to align the information and converge expectations. Finally, a wall of possibilities was created, with all the ideas obtained by the nurses, highlighting two to be discussed.[10.11]

c) Prototyping phase: this stage was carried out within the horizontal classification, that is, in the middle of the project, in which the prototype presents the functionalities of the final version, without going into depth. Within this stage, there are the following classifications: low fidelity, in which the product obtains a minimum level of detail, representing, in a superficial way, the functionalities, but being cheaper and faster to develop; high fidelity, which represents something closer to the final product, with a wealth of details and user experience; vertical prototyping, more focused on branches, refining the functionalities, with the evolutionary being carried out with a development tool and the prototype being used throughout the project, going through several changes; and disposable, in which the product is visualized and, soon after, it is discarded.[10.12]

d) Development phase: in this stage, a prior study was carried out on the idealized product to find out if it was innovative and patentable. A study carried out in Brazil, the United States, Europe and China resulted in a favorable opinion on the bracelet for measuring the blood pressure of hypertensive pregnant women, considered innovative and patent-viable. Next, a market research was carried out in order to seek quantitative data on the number of pregnant women in Brazil and in the world, on the rates of pregnant women with complications due to hypertension and conditions such as preeclampsia, eclampsia and HELLP syndrome treated in the Unified Health System (SUS) and in private health plans, and on health expenses and costs in Brazil and in the world.[10]

The four phases are summarized in Chart 1.

Table 1 - Phases of creation of the technological product

Immersion	Ideation	Prototyping	Development
a) Approach to the problem (pain). b) Investigation of the needs of the target audience.	a) Collecting ideas to solve the problem (pain) through *brainstorming*. b) Elaboration of a matrix of alignment of ideas.	a) Horizontal sorting.	a) Prior art study. b) Market research.

c) Search for information. d) Research, in databases, on the problem addressed.	c) Realization of a mural of possibilities.		

RESULTS

From the *design thinking process*, a bracelet project for hypertensive pregnant women was elaborated. Currently, the product has a patent registration entry at the National Institute of Intellectual Property (INPI) under No. BR 102022017294 3, along with the registration of the Technurse brand for the opening of the company's CNPJ for the development of the product.

The authors participated in several activities aimed at expanding knowledge about the generation of technologies and to disseminate the partial results of the study, such as contests and marathons, in order to test the acceptance of the product. The project was the winner of the Roser National Award for Innovation and Entrepreneurship and was the second highlight in the Entrepreneurship Marathon of the Federal University of Rio Grande do Sul (UFRGS).[13.14]

The incubation is being carried out within the Tecnosinos technology park, in São Leopoldo/RS, where the first minimum viable product was developed, a version in which only the necessary functionalities are enabled to fulfill the function for which it was planned. From this, the minimum viable product will be tested for its efficiency, usability and market acceptance, and comparisons will be made through cross-tests between mean arterial pressure and PPG, as well as between PPG and devices available on the market.

The essence of the project is composed of the integration of a broad communication system, using, for example, 4G, 5G or the local wireless network, establishing a connection with a server hosted in the cloud and thus promoting the security of the data shared between the device and the interface.

Specifically, the device will be aimed at pregnant women with previously known hypertension or in a situation of pre-eclampsia, or even for pregnant women with multiple risk factors for hypertension. From this, the constant monitoring of the blood pressure of the patient at risk is initiated and, during the measurement of the measurements, these will be sent to the server, where the information obtained must be organized, processed and stored. Then, the health team responsible for the pregnant woman receives a notification if the blood pressure is altered. At the same time, the pregnant woman, through an application, will also receive a notification with care guidelines to be followed, in order to prevent the worsening of the condition or having to travel to a health center.

After approval by the Research Ethics Committee (CEP) and completion of the specificity tests – which calculates the percentage of true negatives – and adherence analysis – which analyzes the measurements of different devices at the same time – the product will be validated in pregnant women with hypertension or risk of developing such pathology. This stage is scheduled to take place in the second half of 2023, in partnership with hospital units.[15]

LIMITATIONS OF INNOVATION

The lack of investments and incentives for the acceleration of the project is considered a limiting factor.

CONTRIBUTIONS TO PRACTICE

The process of innovation in the health area has enabled nursing to envision and conquer new spaces of action, making entrepreneurship an important alternative for social and economic development. With the bracelet for measuring the blood pressure of hypertensive pregnant women, it will be possible to contribute to the monitoring of pregnant women at risk, avoiding sequelae and preventing death, as well as reducing costs, hospitalization time and lawsuits.

FINAL CONSIDERATIONS

The construction of this report reinforces and justifies the use of research and innovation strategies for the development of new technologies. The study reflects a fruitful means for the expansion and development of research, encouraging the knowledge of how to plan and build a technological product.

The product developed, described in this report, reflects an innovative practice, with the potential to contribute to the prevention of complications resulting from pregnancy. The bracelet can help optimize processes and speed up the start of interventions, ensuring agile and safer care for hypertensive pregnant patients, who will be monitored in real time.

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