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Enhancing Accessibility in Mexican Healthcare: A Versatile Lift and Walking Aid System

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ABSTRACT

The project focuses on the design and construction of a lift and walking aid system with the purpose of providing a solution to one of the main challenges of interprofessional care that patients with mobility impairments face every day in Mexico. Recent studies reported that 4.9% of the Mexican population has a disability and/or limitations in their social participation; 48% of these being related to motor limitations (INEGI, 2020). The town of Tlajomulco de Zúñiga, located in one of the biggest states of the country with predominantly low-income communities, faces a variety of difficulties regarding access to healthcare services and rehabilitation treatments. Where very few can access private physiotherapy amenities and public ones are usually overloaded and far from specialized clinics. The proposal aims to develop a patient lift for transfer, standing and walking assistance for the rehabilitation clinic located at the University of Tlajomulco de Zúñiga, with the goal of addressing multiple needs with a single and versatile device. The system's design is established considering patients' anthropometric criteria and spatial measurements of the workspace, which ensures the safe and effective application of the device. This initiative would benefit the clinic by equipping healthcare providers with essential tools, optimizing equipment distribution, reducing costs, and most importantly, improving the quality of life for patients. Furthermore, the device's adaptability allows for its use in serving the needs of other patients with similar requirements in the future.

Keywords: Patient lift, Rehabilitation, Accessibility, Mobility impairments, Human-centered design

INTRODUCTION

Gait training plays a fundamental role in the recovery process for individuals who have experienced limitations in their ability to walk due to a wide range of conditions, such as traumatic injuries, orthopedic surgeries, strokes, and neuromuscular diseases. It's a rehabilitation process designed to enhance the standing and walking capabilities.

Standing is inherent to the human condition, it requires the capability of maintaining an upright posture of the lower limbs, when these abilities are lost the rehabilitation process begins by restoring standing capability. This process involves close supervision and guidance from a physical therapist,

who may employ various therapies, techniques, and exercises. Most of these approaches require the use of devices and tools that provide support for both the patient and therapist during walking and standing activities, such as parallel bars, standers, patient lifts, and other assistive equipment. By facilitating standing and promoting the development of gait training with specific devices, the effectiveness of the rehabilitation process is optimized, thereby contributing substantially to the improvement in patients' autonomy and quality of life, enabling them to reintegrate into their daily activities independently.

Despite advances in rehabilitation technology, current devices face challenges such as limited versatility, a lack of adaptability to individual patient needs, and inclusivity issues for diverse medical conditions. The associated difficulties in using these existing devices can pose barriers for both patients and caregivers, affecting the effectiveness and continuity of the rehabilitation process.

A significant challenge is that most patient lifts available today serve a singular function—patient transfer. Consequently, rehabilitation often requires additional auxiliary devices, such as parallel bars, which can be challenging for patients lacking sufficient lower limb strength. This not only heightens the risk of falls but also places physical strain on physiotherapists attempting to provide adequate support.

Given these numerous challenges associated with existing approaches, this proposal aims to design and develop a versatile and adaptive standing and walking aid system. The objective is to combine the benefits of various existing equipment, integrating them into one device capable of addressing multiple needs and overcoming the usability issues implicated in the use of single-purpose aids.

MATERIALS

Table 1. List of materials used throughout the design and development process of the device.

Item		Description
Instrument	Windows PC	Personal computer with a Windows operating system. Used as a platform to run and operate design software.
	Anthropometer	Instrument used to measure widths and lengths of human body segments. Employed to obtain specific anthropometric data of subjects.
	Measuring Tape	Flexible measuring instrument used to obtain precise measurements of length and size of the subject and space to design and define the size of the lift.
Software	AutoCAD	Computer-aided design (CAD) software used for creating 2D drawings and 3D models. Used in the conceptualization and detailed creation of blueprints of the lift.
	SolidWorks	Software used for modeling, simulation, and product design. Utilized in the creation and detailed three-dimensional visualization of the lift, allowing for accurate virtual representation and simulation.

PROCESS AND DEVELOPMENT PHASES

The development process of the device is categorized into three main phases.

Phase 1: Field Study and Current Device Challenges Analysis

Studies showed 4.9% of the Mexican population experiences some form of disability, with 48% reporting motor limitations such as walking or moving. These individuals often require assistance with mobility, turning to caregivers or rehabilitation professionals. Within the context of the CUTLAJO clinic, two major issues were identified: the potential for injuries to both patients and physiotherapists and challenges in transferring patients due to their weight. Consequently, an investigation into existing transfer devices was conducted, revealing specific needs, including the requirement for adaptable parallel bars catering to pediatric, adult, and geriatric populations. As a result, a technical assistance device is proposed to aid patients with motor disabilities.

Most of the requirements for human systems integration are derived from requirements for performance, efficiency, environmental, operational, maintenance, and training (see Table 1). Some will be buried in mechanical and electrical requirements. One of the obstacles to realizing the substantial potential of HSI is the lack of clear articulation of human engineering requirements in the Statement of Work (SOW) or other authorizing documentation received from the customer, and the lack of a HSI software or architecture framework to track requirements changes.

Phase 2: Formulation, Concept and Data Compilation

To address issues arising from existing equipment during walking and standing therapies, the idea of a multifunctional Patient Lift is proposed. Combining benefits from multiple aid systems used during rehabilitation, the device aims to eliminate complications associated with current equipment. Patient lifts and standers are useful for standing and transfer assistance, but they serve only that purpose, while parallel bars, although vital for gait training, tend to occupy a significant amount of space. Combining these systems into one versatile rehabilitation aid would provide a compact solution adaptable to the specific needs of individuals, regardless of age or physiology, suitable for various spaces such as small clinics or houses.

Specific measurements for the patient lift were defined based on anthropometric criteria and spatial considerations. Anthropometric criteria included height, hip height, shoulder breadth (bideltoid), waist circumference, step width, and handle diameter, with percentile calculations ensuring adaptability to various body types and ages. Spatial measurements, such as door width and height, were also considered to avoid complications related to space when introducing the lift into the clinic. Once data was gathered, and system features were determined, the design phase commenced.

Phase 3: Design, Development and Feasibility

The proposal for a multifunctional patient lift features an ergonomic standing system and switchable parallel bars for gait training, aiming to address

multiple needs through a single device. Initial drafts involved a sketching process to determine the main structure, mechanisms, components, and materials. Blueprints were then created using AutoCAD software, illustrating the entire device and each part precisely.

Scale models were also carefully crafted in order to verify the feasibility of the design and identify potential areas for improvement. After multiple design proposals and prototypes, the final design was 3D modeled using SolidWorks software, providing a rendered and realistic representation. This allowed for structural and force analysis and simulations, ensuring the safe and effective application of the device before its physical construction.

RESULTS

The proposed and designed patient lift features various mobility aid systems that combine the advantages that multiple devices offer, integrated into a single and versatile device that could be used during the rehabilitation process of individuals with motor impairments. This lift would not only facilitate the standing and transfer process of patients, but would also be beneficial to the different stages of gait training.

The inclusion of adaptive mechanisms, such as switchable and adjustable parallel bars, along with a wide range of height levels, ensures the lift's suitability for individuals of all ages. This feature makes the rehabilitation process more effective and accessible to a larger population. The anthropometric and spatial data considered for the design would also ensure the safe and proper application of the device.

At its current stage, the project encompasses the complete structure, materials, mechanisms, and implementations of the device. Further studies and analyses are underway to consider all implications before initiating the physical construction and application of the lift.

DISCUSSION

In the current market, there are various patient lift devices; however, most are limited to the simple task of transferring patients from one place to another, without addressing gait training. This lack of versatility makes them impractical tools, especially when considering their implementation in clinics, homes, or hospitals. In many cases, auxiliary devices such as parallel bars are required, and in some instances, the installation of ceiling rails is necessary to address the patient's gait training.

The proposed design addresses multiple needs in a single device, providing a comprehensive solution. Thanks to its parallel bars with adjustable size and shape, this device can cater to both pediatric and geriatric areas. This adaptability is not found in conventional patient lift devices, which are generally designed only for adults meeting standardized height requirements. In addition to optimizing available space and being economically viable, this patient lift stands out for its unparalleled versatility in caring for patients of different ages and conditions.

Another significant advantage is that this design allows for the optimization of available space. Besides being economically viable, a single device can address various needs.

The project significantly contributes to the comprehensive health care of both the patient and the caregiver by providing an all-encompassing solution for gait training. By implementing patient lift with stander and rehabilitation functions, this multifunctionality creates a secure space for both the patient and the caregiver. It allows the patient to perform exercises starting from the most basic phase, which is stand positioning, with the patient lift support to facilitate this position. Subsequently, it enables the gait training process on the same device, providing support through the lift and positively contributing to the patient's recovery by instilling psychological and physical confidence for secure exercise execution. Facilitating this process reduces the risk of injuries and enhances the quality of care received by the patient.

The adaptability of the patient lift in various spaces enables personalized rehabilitation according to the specific anatomical conditions of each patient. By facilitating stand position and gait training, it alleviates the physical burdens on the caregiver; transfer and assistance tasks can be demanding for the caregiver, and these implementations aim to alleviate such physical demands.

Collectively, these features enhance the overall rehabilitation experience for both the patient and the caregiver, offering a comprehensive approach that optimizes safety, comfort, and the effectiveness of the recovery process.

CONCLUSION

The exploration and development of a multifunctional patient lift have uncovered significant considerations and opportunities in the realm of rehabilitation technology, committing to pursue physical healing and the efficient optimization of space, along with an inclusive design catering to various patient needs.

The multifunctionality of the patient lift, encompassing stander and rehabilitation functions, contributes not only to the physical recovery of the patient but also to the recognition that the ability to walk transcends mechanical function, addressing psychological, emotional, economic, and social aspects. This acknowledgement extends to patients, caregivers, and hospitals, marking a progression towards comprehensive and adaptive solutions that integrate elements promoting confidence and space optimization. The reduction of physical burdens on caregivers and the personalized rehabilitation approach add layers of depth to the device's significance in enhancing the overall healthcare experience. This improvement, therefore, enhances the quality of life for patients and ensures the safety of caregivers by establishing a rehabilitation process within a secure and controlled environment.

As the project progresses into further design refinement, studies and analyses, the commitment to considering all implications before physical construction emphasizes the dedication to ensuring the device's safety, effectiveness, and real-world applicability, reflecting a commitment to continuous improvement in accessible rehabilitation technology.

In essence, this project represents more than the development of a patient lift; it symbolizes a paradigm shift in how the complex needs of individuals with motor impairments are approached and addressed—from identifying challenges in existing systems to proposing a transformative solution in the field of healthcare technology.

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