

Hydraulic Rehabilitation Chair: A Supportive Solution for Patient Recovery

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Abstract

A hydraulic rehabilitation chair is designed to support the physical and mental rehabilitation process of individuals. Physical injuries and the inability to move independently are the main challenges for patients in the rehabilitation process. However, most of the rehabilitation chairs currently on the market are expensive, have limited functions, and are not suitable for use in small treatment institutions or at home. Therefore, this study was conducted to develop a hydraulic system-based rehabilitation chair that is ergonomic, safe, easy to use, and affordable in terms of cost. The main objective of this study was to design and develop a hydraulic rehabilitation chair that can help users more quickly and change sitting and lying positions more easily and comfortably, while reducing dependence on physical assistance from caregivers. The methodology of this study includes the mechanical design stage using CAD software, selection of appropriate hydraulic components, prototype construction process, and functional testing of time effectiveness and safety of use of the chair. This chair is able to meet the basic needs of rehabilitation and provide effective support. It is hoped that it can contribute to the development of innovative and high-impact local rehabilitation products.

Key Words: *Hydraulic Rehabilitation Chair, Recovery, Patient, Support*

1.0 Introduction

The hydraulic rehabilitation chair is not only focused on the physical aspect but also considers the psychological element by providing a comfortable and relaxing environment. This can help reduce stress levels and improve quality of life during the recovery process. According to Chan, C.K., Lee, T.M., & Pang, M. Y. (2017), rehabilitation chairs not only focus on the physical aspects but are also important for the psychology of the patient. This can help reduce stress levels and improve the quality of life during the rehabilitation process. Therefore, these chair serves as an important tool in achieving better recovery results and improving the overall recovery experience. To meet the needs of human recovery whether during illness or not, it is necessary to design products for the active recovery of patients. Existing rehabilitation chairs use the concept of adjustable, easy to operate, physical disabilities and can help move the patient safely. According to Zemp, R., Taylor, W. R., & Lorenzetti, S. (2015), this supports the argument about the need for ergonomic design in rehabilitation chairs to support body posture and reduce pressure on the affected body parts. In addition, the mobility issues of normal wheelchair users are difficult, and traditional aids are often not suitable.

The main function of the hydraulic rehabilitation chair is to facilitate the recovery process after surgery, injury, or chronic illness. Some people were suffered from the inability to move. It also covers people who are paralyzed, have limb injuries or have slip disc disease. Most of these individuals will be bedridden and will require the assistance of others as well as additional devices such as a wheelchair. As everyone is aware, most wheelchairs in hospitals or those widely used by these patients can only be used to transport people who are unable to walk to specific locations such as hospitals, school, and so on. Wang, H., Zhang, Y., & Xu, Y. (2019) also support the advantages of using a hydraulic system in assisting the movement of patient from bed to chair and to the toilet without great stress on the caregiver. Normal wheelchairs usually require more energy than others to move them from bed to wheelchair. To move the patient, the individual must cradle or support them. This has various causes that develop such as the occurrence of accidents such as falling, slipping, adding additional pain

to the patient, and it can also diminish the energy of other individuals since strong energy is required. As a result, the idea to convert a standard wheelchair into a hydraulic rehabilitation chair that does not require a lot of work from other people to raise and transport the patient from the bed to the wheelchair. The hydraulic power allows this hydraulic rehabilitation chair to be transported to the bed and adjusted up and down. Aside from that, this hydraulic rehabilitation chair can be brought to the toilet and bathed in without removing the patient.

By considering the original concept of a normal wheelchair, hydraulic rehabilitation chair is designed to help in the process of physical and therapeutic rehabilitation of a person. The design concept of this chair usually involves several key elements such as ergonomic fit to support correct body posture and reduce pressure on affected body areas. This includes height, angle, and back support adjustments to ensure comfort and effectiveness in recovery. In addition, the ability to change is one of the main design factors, which is that many rehabilitation chairs can be adapted to individual needs, such as adjusting the height, the angle of the backrest, and the position of the legs, to facilitate daily activities and therapeutic exercises. To maintain the quality and cleanliness of the material, the chair is designed to provide long-term comfort and is easy to wash, especially if used in a medical context.

2.0 Literature Research

Hydraulic rehabilitation chairs have gained increasing attention in recent years due to their vital role in improving mobility, comfort, and functional independence in individuals undergoing physical rehabilitation. A review of current literature highlights significant advancements in design, clinical application, and patient outcomes associated with these specialized chairs. It differs from traditional wheelchairs by offering enhanced support and therapeutic functions. Many studies have emphasized their importance in both inpatient and outpatient rehabilitation settings. According to Park et al. (2019), chairs with adjustable backrests, tilt-in-space mechanisms, and leg support not only improve sitting tolerance but also reduce the risk of pressure ulcers in patients with limited mobility. These features are particularly beneficial for patients recovering from strokes, spinal cord injuries, and orthopedic surgeries.

In addition to physical support, rehabilitation chairs contribute positively to therapy outcomes. Thompson and Lee (2018) found that stroke patients who used rehabilitation chairs with posture support showed greater improvements in trunk stability and balance compared to those using standard seating. Similarly, Singh et al. (2021) reported enhanced lower limb strength in patients using chairs equipped with active pedaling mechanisms as part of their recovery program. Comfort and safety are also frequently cited themes in the literature. Gonzalez et al. (2020) highlighted that well-padded chair with proper lumbar and neck support reduced fatigue and discomfort during prolonged sitting. These findings underline the importance of ergonomic design in promoting patient compliance and long-term rehabilitation success.

Technological innovations are further expanding the potential of rehabilitation chairs. Modern designs now include integrated sensors and feedback systems that help monitor posture, pressure distribution, and movement patterns. Li and Zhang (2022) demonstrated that data collected from smart rehabilitation chairs can be used to personalize therapy plans, improving patient outcomes and reducing the risk of complications.

Despite these advancements, there are still gaps in research. Many studies are limited in scope or duration, and there is a lack of standardized guidelines for evaluating the effectiveness of rehabilitation chairs across different patient groups. More longitudinal and

comparative studies are needed to fully understand the long-term benefits and best practices for integrating these devices into rehabilitation programs.

3.0 Methodology

To realize this hydraulic rehabilitation chair as a ready-to-use product with safety features, a very comprehensive plan was implemented. Data collection and survey interviews from users at the PSA Clinic greatly aided its production. A total of 35 users were interviewed. It consists of medical assistants, students and staff who come for treatment. After that it started with understanding the design concept based on the findings of the interview. Research was conducted to understand the design of previous inventions. Then product sketches, material selection and then assembly and fabrication. After the hydraulic rehabilitation chair was created, durability tests were carried out through the user's body weight, patient transfer time was measured, the strength and smoothness of the wheels under maximum load.

Mild steel was used for the chair frame. It is preferred because of its thick and strong structure. It can withstand the load of the patient who will sit on the chair to be produced. Stainless steel was chosen because it is very well known for its rust resistance. It will save costs because it does not need to be maintained and is suitable for use in wet places such as toilets, rainy days and open places. By using about 2 heavy-duty rod wheels on the chair, the load will be accommodated well. They are placed at the back so that it can be equipped with a brake function. While the wheel ability can rotate 360 degrees and is easy to control. For added user comfort, special cushions are placed on the seat and armrests. And the most important element in the production of chair recovery is the hydraulic pump that will raise and lower the user's load to the appropriate level before being moved. The design as shown as Figure 1.

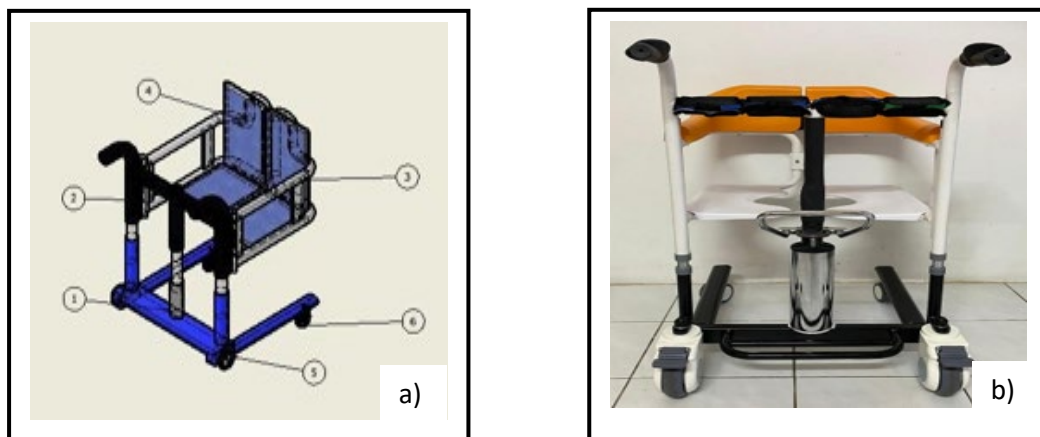


Figure 1.0: (a) design concept (b) hydraulic rehabilitation chair

4.0 Material and Method

The selection of appropriate components is crucial in the design of a hydraulic rehabilitation chair to ensure safety, durability, and comfort for users. Using the right materials helps prevent misuse and enhances the chair's performance during rehabilitation. Key structural components such as mild steel cylinder tubes, hollow sections, and plates provide strength and stability. Heavy-duty wheels and brake wheels support safe mobility, while comfort is ensured through features like the chair cushion and ergonomic backrest. Safety is further enhanced with components like the car belt clip, and adjustability is achieved with the hydraulic pump. Stainless steel is also used for parts requiring durability and corrosion

resistance. Overall, each component plays a specific role in creating a functional, reliable, and user-friendly rehabilitation chair that supports effective recovery.

5.0 Result and Discussion

A Patient Transfer Efficiency Test was conducted. The purpose of this test was to evaluate and compare the efficiency of transferring a non-ambulatory patient from a wheelchair to a patient bed using two different assistive devices, namely a hydraulic rehabilitation chair and a conventional wheelchair (manual lift). Two assistants were used. The key performance indicator measured was the time required for each transfer, with the aim of assessing the time saving benefits, workflow efficiency and potential for reducing caregiver burden. The results obtained were a time saving of approximately 3.5 minutes per transfer. If this process was performed 5 times a day, the total time saved was approximately 17.5 minutes per day. Over the course of a week, caregivers could save more than 2 hours simply by using a hydraulic rehabilitation chair. The time measurements were taken and recorded as Table 1.0.

Table 1.0: Time Difference (Practical Simulation)

No	Transfer Activity	Manual Lifting	Hydraulic Rehabilitation Chair	Reflection
1	Preparing the patient	2 minutes	1 minutes	Fast
2	Lifting and transferring	3 minutes	1.5 minutes	Fast
3	Adjusting the patient	1.5 minutes	0.5 minutes	Fast
	Total Time	6.5 minutes	3 minutes	Fast

Data shows that the use of this hydraulic rehabilitation chair saves an average of 50% of transfer time compared to conventional methods. In addition, this chair also improves patient safety by supporting the body stably during transfer, thus reducing the risk of falls and injuries. The chair also appears stable when tested when the user's maximum strength and weight are less than 95kg. If this range is exceeded, the lifting pump force is less effective. For caregivers, the easy-to-operate hydraulic control system allows transfers to be performed more easily and with less physical stress, especially on the patient's back and shoulders.

6.0 Conclusion

The development of the hydraulic rehabilitation chair has shown promising potential in improving the overall quality of patient recovery. By integrating a manually adjustable hydraulic system with an ergonomic design, the chair offers a practical and cost-effective solution that supports safe, efficient and comfortable patient transfers. The study found that the chair not only reduces the time required for movement and repositioning, but it also significantly improves patient safety by minimizing the risk of falls and strain-related injuries. Suggestions for future product improvements include adding electronic control systems such as motors and remote controls to facilitate patients and caregivers with technical and energy skills. In addition, pressure, position and weight sensors will be added to maximize safety. Overall, the hydraulic rehabilitation chair eases the burden on caregivers, allowing them to perform transfers with less physical effort and greater confidence. These combined benefits make the chair ideal for use in hospitals, rehabilitation centers, senior care facilities, and even home environments.

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