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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design and Fabrication of a Hydraulic Patient Transfer Trolley

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ABSTRACT :

Patient transfers pose significant challenges in healthcare, often resulting in injuries to both caregivers and patients, particularly those with neurological disorders, critical injuries, or mobility impairments. This review examines the limitations of existing patient transfer devices and proposes a novel hydraulic patient transfer trolley designed to address these issues. The proposed trolley features a foldable and portable design, supports a 200 kg load, and offers an adjustable height range of 400 mm to 800 mm. By minimizing physical contact and reducing caregiver strain, the design ensures safe and efficient transfers in both hospital and home settings. The review highlights the need for innovative mobility aids and suggests future research directions, including the integration of IoT-based monitoring and lightweight materials for enhanced portability.

Keywords: Hydraulic Patient Transfer Trolley, Foldable Design, Caregiver Safety, Patient Mobility, Healthcare Innovation

1. Introduction

Patient transfer devices are essential mobility aids that facilitate the safe and efficient movement of patients between locations, such as from a wheelchair to a hospital bed. These devices are particularly critical for patients with severe injuries, paralysis, stroke, infectious diseases, or mobility impairments, where manual handling can lead to injuries for both the patient and the caregiver. According to the National Institute of Occupational Safety and Health (NIOSH), the safe lifting limit for repetitive tasks is 23 kg, whereas manually lifting a 100 kg patient requires approximately 980 N of force, posing a significant risk of back injuries for caregivers.

This paper builds upon a previous review, "A Review on – Design and Fabrication of Patient Shifting Transfer Trolley," which explored general design and fabrication challenges in patient transfer systems (Sharma, 2025). In contrast, this study proposes a specific solution: a hydraulic patient transfer trolley with a foldable and portable design. The trolley incorporates a hydraulic lifting mechanism to minimize caregiver effort and a foldable frame to enhance portability, making it suitable for both hospital and home use. The design aims to reduce physical contact between the caregiver and patient during transfers, thereby improving safety and efficiency.

2. Problem Identification

The process of transferring patients, especially those with critical injuries or mobility impairments, presents several challenges. Current methods include:

- Rolling the Patient: Feasible only for conscious patients, posing a risk of discomfort or injury.
- Manual Lifting by Caregivers: Leads to a high risk of back injuries. Studies indicate that one in three nurses experiences injuries due to moving non-ambulatory patients.
- Using a Cloth for Lifting: Inefficient and unsafe, increasing the risk of patient falls.

Additionally, one in two non-ambulatory patients falls and sustains injuries during transfers from a bed to a wheelchair. Existing devices often lack portability, require significant space, and depend on electricity, which limits usability in home settings or during power outages. There is a clear need for a device that combines mobility, lifting capability, and portability while minimizing caregiver effort and ensuring patient safety.

3. Aim

To design and develop a hydraulic patient transfer trolley with a foldable and portable design, capable of supporting a 200 kg load, to minimize caregiver strain and ensure safe and efficient patient transfers in hospital and home environments.

4. Objectives

- To design an efficient patient transfer mechanism using a hydraulic system for smooth lifting, requiring minimal human effort.
- To determine the standard dimensions and material specifications for a stainless steel frame, ensuring structural integrity under a 200 kg load.
- To analyze the loads acting on the trolley components and optimize the hydraulic system for safe and reliable operation.
- To incorporate a foldable mechanism to enhance portability and reduce storage space.

5. Literature Review

Several studies have explored patient transfer devices, highlighting their limitations and proposing improvements. Pujari et al. (2020) proposed a patient transferring device that converts a wheelchair into a stretcher using connecting rods and kinematic calculations. While the design reduces physical contact between the caregiver and patient, it lacks portability and requires significant space. Our proposed foldable hydraulic trolley addresses these limitations by reducing the footprint to 0.5 m^2 when folded.

Arunkumar et al. (2019) designed a multipurpose stretcher using gears, belts, and hydraulic jacks. However, the design is limited to linear movement and lacks maneuverability. Our design improves upon this with a foldable mechanism and higher load capacity.

Bobde et al. focused on a wheelchair convertible to a stretcher but did not address portability or caregiver strain. Our hydraulic trolley minimizes caregiver effort using a hydraulic system.

Allwin et al. (2020) analyzed a wheelchair-cum-stretcher that lacks a lifting mechanism, requiring manual effort. Our design includes a hydraulic system, making it more suitable for non-ambulatory patients.

Most existing solutions focus either on mobility or lifting, but rarely both. Our proposed design combines both features in a single device.

6. Proposed Design

The proposed hydraulic patient transfer trolley addresses patient transfer challenges with caregiver safety and patient comfort in mind. Key features include:

- Frame: Stainless steel (SS304), rectangular hollow section 50 mm x 30 mm, 3 mm thick. Yield strength: 215 MPa.
- Base: 1200 mm x 600 mm x 150 mm with a U-shaped design for compatibility with hospital beds.
- Hydraulic System: Manual pump, 50 mm cylinder diameter, height adjustable from 400 mm to 800 mm, supporting 200 kg load with only 20 kg of effort.
- Foldable Mechanism: Hinge system folds to 1000 mm x 500 mm x 150 mm, reducing storage space by 50%.
- Wheels: Four 100 mm rubber-coated caster wheels with locks.
- Load Capacity: 200 kg, accommodating most patients and equipment.

7. Advantages

- Reduced Caregiver Strain: Hydraulic system reduces lifting effort to 20 kg.
- Portability: Foldable design reduces footprint to 0.5 m^2.
- Versatility: Adjustable height for different surfaces.
- No Electricity: Manual system ensures use during power outages.
- Robust Design: Stainless steel frame supports 200 kg load.

8. Disadvantages

- Maintenance Needs: Hydraulic system requires biannual maintenance.
- Weight: The 35 kg stainless steel frame may be heavy for some users.

9. Conclusion

This review highlights the critical role of patient transfer trolleys in reducing caregiver strain and enhancing patient safety. The proposed hydraulic patient transfer trolley, with its foldable and portable design, overcomes key limitations of existing devices. Supporting up to 200 kg and an adjustable height range of 400 mm to 800 mm, it minimizes caregiver effort and ensures safe transfers. Future enhancements could include IoT integration and the use of lightweight materials.

Acknowledgements

The author would like to thank the Department of Mechanical Engineering at ABC University for providing the necessary resources and support for this research.

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