QuinLift - 2025 Final, Designathon

Elevating safe movement, one stair at a time.

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1. Abstract

Post-operative patients frequently experience restricted mobility that limits independence and increases caregiver dependency. Conventional walkers are primarily designed for flat, stable surfaces and often fail in multi-level home environments. This proposal introduces the QuinLift, an adaptable multi-wheel attachment system that retrofits onto standard walkers to enable stair and incline navigation, and adaptive height adjustment. The system prioritizes safety, comfort, and autonomy, offering patients a low-cost, mechanical solution to regain mobility during recovery.

2. Background and Problem Definition

Across the world, the most commonly performed surgeries include orthopedic (knee and hip replacements, spinal fusions), cardiac, neurological, and abdominal and lumbar. Recovery processes are highly individualized, with older patients often facing greater obstacles.

From numerous conversations with orthopedic surgeons, occupational therapists, and medical staff, individuals struggle primarily with independence performing everyday tasks, typically getting into and out of bed, using the bathroom, and navigating their homes. This difficulty often results in extended stays and frequent return trips to the hospital.

The volume of joint replacement surgeries (hip and knee) continues to grow, emphasizing the need for innovative solutions to make post-operation life easier. An estimated ~1.3 million knee replacements and ~766,000 hip replacements were performed in the U.S. in recent years (combined ~2.06 million). These patients often rely on assistive devices like walkers during recovery, especially in the early weeks and months post-surgery.

Despite ongoing innovation, current walking aid products frequently struggle to provide seamless, accessible travel. Standard walkers, canes, and other assistive products are not optimized for stair or incline navigation; they lack mechanisms to ascend and descend steps safely. Additionally, patients with limited strength or mobility may require caregiver assistance for vertical transitions. This dependency reduces patient autonomy, slows rehabilitation progress, and increases the risk of falls or injuries. Having a limited range of motion can be discouraging, and the cycle of experiencing pain leads to fear and immobility, resulting in more damage in the long run.

Most importantly, products that claim to address these issues require inconvenient installations, are out of the price range for a majority of patients, and are not very versatile.

Thus there is a clear need for a retrofit accessory that enables standard walkers to perform safely and comfortably in multi-level home or rehab environments, thereby improving patient independence and reducing caregiver burden.

3. Project Objectives

The QuinLift Adapter aims to:

- Enable safe navigation of stairs and inclined surfaces for walker-using patients.
- Provide intuitive height adjustment of walker legs to adapt to terrain changes or stair-landing transitions.
- Reduce dependency on caregivers for basic mobility in recovery and rehabilitation phases.
- Be compatible (retrofit) with existing walker frames to minimize cost and adoption barriers.

- Improve patient confidence, mobility and rehabilitation outcomes by increasing independence of movement.

4. Design Overview

4.1. System Architecture

The system consists of two modular attachments:

a. *Front Penta-Star Wheel Adapter*:

- A rotating hub assembly with five equally spaced wheels in a "star" configuration mounted onto each front leg of the walker.
- As the walker approaches a step, the wheel assembly rotates/up-cycles so that one wheel contacts the landing next, allowing the walker to climb the step while maintaining ground contact, reducing lift effort.
- Provides smoother traversal of stairs or obstacles.

b. *Rear Lever-Activated Height Adjustment System*:

- A hand-operated brake-pedal located on the handles of the walker.
- Depressing the lever retracts spring-loaded height-lock pins on both front and rear walker legs via a linkage, allowing simultaneous height adjustment of either the front or rear legs.
- Releasing the lever re-engages the pins, securing the walker at the new height.
- Allows users (or caregiver) to easily adapt walker height for e.g. half-landing or step-up/down transitions without manual leg adjustment.

4.2 Mechanical Design and Materials

- The penta-wheel hub: central hub (approx. 20 mm diameter) mounted to walker leg with adapter sleeve; wheels made of high-durability polymer or small cast aluminium with non-marking rubber tread.
- Height adjustment system: stainless steel rods, spring-loaded pins, linkage cable or rod connected to the pedal; pedal arm made of aluminium alloy with thermoplastic elastomer foot pad for user grip.
- All components designed for retrofit onto commercial walker frames (typical leg diameters) via clamp or bolt-on adapter; no permanent modification of the walker required.
- Safety features include: non-slip foot pads, anti-rollback detents in wheel hub to prevent sudden drops, audible/ tactile click when height pins lock, design margin to support 250 lb+ load (typical walker load + user lean).
- Materials selected for strength, durability, lightweight operation, and low cost—supporting manufacture at scale.

4.3 Operation Procedure

- Attachment: Using quick-release clamps or bolt-on adapters, the front penta-wheel assemblies are mounted onto the front walker legs; the rear height-adjustment module is mounted on the rear legs with linkage rods/cables to the pedal.
- Height Adjustment: When terrain changes (e.g., approaching stairs or an incline), the user depresses the hand level. This simultaneously unlocks the height pins on all legs, allowing the walker height to be adjusted (raised/lowered) by the user or caregiver. Releasing the pedal locks the pins in the new height.
- Stair Navigation: The user pushes the walker towards the step. The penta-wheel hub rotates as it contacts the step edge, lifting the walker smoothly to the next level. The user steps up/forward using the walker for support and continues.

- Return to Flat Surface: Upon reaching level ground again, the user may depress the lever l to readjust height to standard setting, then proceed as with a normal walker.

This intuitive method enables the walker to adapt to environment changes, while maintaining stability and user control.

5. Market Analysis

5.1 Target Demographic

- Primary Users: Patients recovering from orthopedic, neurological, and cardiac surgeries who rely on walkers for early mobility, strength, or stability; older adults with limited strength or balance who use walkers; rehabilitation centre patients undergoing mobility recovery.
- Secondary Markets: Hospitals, physical rehabilitation clinics, home-care agencies, and assisted-living facilities that provide mobility aids to residents.

5.2 Market Opportunity

- An estimated 12.2 % of U.S. adults report serious difficulty walking or climbing stairs (mobility disability). CDC+1
- Annually in the U.S., approximately 1.3 million knee replacements and ~766 000 hip replacements were estimated in 2022 (combined ~2.06 million). AAHKS | Educate. Advocate. Investigate.
- With an aging population and increased joint-replacement rates, mobility-aid demand continues to grow. For example, projected demand for knee arthroplasty alone is >3 million by 2030. Medbridge+1
- Existing walkers rarely support safe stair/incline navigation, and motorised stair-climbing mobility aids are often expensive, complex or hospital-bound rather than home-use. This creates a gap for an affordable, mechanical stair-assist retrofit.

5.3 Value Proposition

Feature	Standard Walker	QuinLift
Terrain Compatibility	Flat surfaces only	Flat surfaces + stairs/obstacles
Height Adjustment	Manual leg pins only	Use of a brake-like mechanism to retract and lower legs
Independence	Often caregiver-assisted on stairs	Enables user autonomy on stairs, navigation inside and outside
Retrofit Compatibility	May require specialized walker	Compatible with existing walker frames
Cost & Complexity	Low cost but limited function	Moderate cost, added function without major complexity

The QuinLift solves a major complication with post-operation life: enabling safe multi-level mobility with existing walkers, reducing caregiver dependency and improving recovery mobility.

6. Expected Outcomes

- Functional Outcome: Recovering patients will be able to safely navigate stairs (with walker support) and adjust walkers to various heights and terrains.
- Rehabilitation Outcome: Increased mobility and independence may accelerate recovery, increase patient confidence, and reduce risk of secondary immobility complications (falls, pressure injuries, deconditioning).
- Economic Outcome: By retrofitting existing walkers rather than requiring fully new devices, cost to patients or facilities is lower; caregiver labour costs or dependency may reduce. There is no longer an incentive to buy more expensive equipment; a base walker and our attachment drastically reduces the cost. This would be the first universally compatible walker product on the market that allows for climbing.
- Social Outcome: Empowering patients to move independently improves quality of life and confidence in the recovery process, allows greater access to full home environments (not just ground-floor) and reduces burden on caregivers.

7. Conclusion

The QuinLift transforms a conventional walker into a multi-level mobility aid, enabling patients recovering from surgery (or with limited strength) to regain independence in home and rehabilitation environments. By combining a mechanically driven penta-wheel climbing mechanism and pedal-activated height adjustment, this device addresses the significant gap in walker function: safe stair and incline traversal. With verified market data and growing need (mobility disabilities, joint replacements), this solution offers substantive value in terms of autonomy, safety and cost-effectiveness. We believe it to be a viable, scalable innovation for rehabilitation and home mobility.