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From 2016 to 2020 hospitalization for lower extremity injuries increased from 130,000 to 180,000 patients accounting for 13% of all emergency department admissions (Albright et al., J Emerg Med, 2022). Most lower extremity patients require rehabilitation for injuries and a non-weight bearing period which lasts for 4 to 6 weeks or longer depending on the severity of the injury (Lynch et al., Curr Rev Musculoskelet Med, 2017). Medical professionals prescribe tools such as crutches, canes, scooters, and wheelchairs to assist with daily activities at home; however, there is a notable gap in suitable and safe mobility solutions for navigating stairs during the recovery process. Traditional devices are not specifically designed for stair use and may pose safety risks or discomfort for patients recovering from below-knee injuries.

A commercially available alternative to standard crutches that was recently launched is the iWalk™ hands-free crutch (HFC). This device provides support to the lower leg in a bent position while freeing the upper extremities for use during walking. iWalk was awarded a design patent US10624810 B2 April 2020 and has international patents awarded in Brazil, China, Canada, Europe and Mexico (Patent Public Search, USPTO, 2024).

While the iWalk is noted for its benefits on level surfaces, it can be cumbersome and inconvenient to use when traversing stairs (Kutchera, 2023). This limitation opens up opportunities for the development of novel solutions to enhance mobility and safety for individuals with below-knee injuries during stair ascent and descent. The global market for stair lifts and climbing devices, valued at \$2 billion in 2023, is projected to be \$4.1 billion by 2032. Although it is difficult to predict the available market for a device at such an early stage, capturing as little as 1% of this market could represent over \$20M of revenue.

Our design process focused on developing a safe, user-friendly, and lightweight mobility aid. The stair-assisting bench (SAB) features a central height-adjustable column to accommodate various users, a cushioned bench for resting non-weight bearing limbs, along with a fixed handle to facilitate bench movement between stairs. The central column is anchored to a custom designed aluminum footplate ensuring stability of the device. The SAB's innovative footplate design maximizes support and contact area, promoting weight-bearing stability and allowing the device to stand independently when not in use. The compact leg platform and cushion design offer comfort and versatile lower limb support without interfering with walking boots or casts.

The testing methodology involved 5 healthy participants undergoing trials with various interventions, including a fracture boot, SAB, and HFC. Participants ascended and descended stairs under different conditions while motion capture and force plate technology captured kinematic and kinetic data to verify that the SAB provided sufficient stability. Feedback forms, including pain ratings and comfort evaluations, were collected to assess balance, ease of use, and device preference. The testing aimed to compare the effects of different assistive devices on gait biomechanics and participant preferences during stair climbing.

This new device addresses the needs of patients recovering from below-the-knee injuries who face challenges when navigating stairs. It was designed to improve the lives of patients, giving them a reliable tool to maintain independence and support at-home recovery. The key design requirements defined by our client included comfort for the user, sufficient load capacity, overall stability, and adjustability. It is believed that this new SAB will offer a practical solution for those with weight-bearing limitations, providing a means to safely navigate stairs at home, which is crucial during the rehabilitation period.