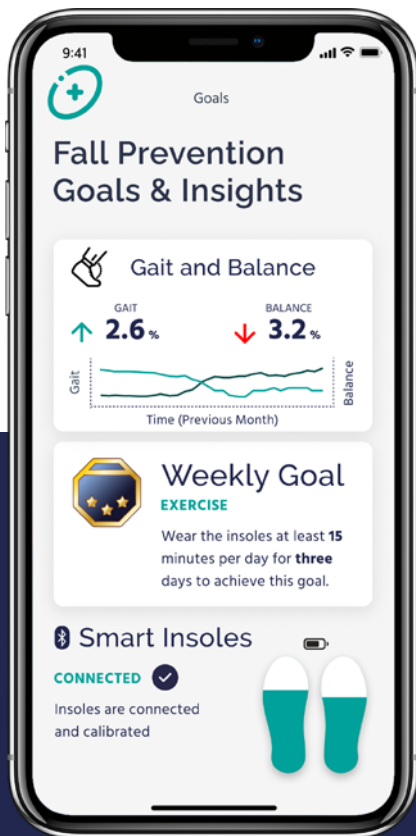# celestra
health systems

Falls Prevention
September 2022

Every individual has their own unique gait signature; Celestra Health's AI-powered medical-grade technology is uniquely positioned to identify your gait signature and to detect subtle changes in over time, including the ongoing monitoring of your risk of falling.

We provide patients and clinicians with clear and concise objective insights that would otherwise go undetected, whether it is a patient with Multiple Sclerosis (MS) or Parkinson's whose disease is progressing or an elderly person who is at increased risk of falling. In the event of increased fall risk, the user and their caregiver / clinician are proactively notified so they can take measures to minimize the likelihood of a potentially catastrophic fall.

9:41   Goals

Fall Prevention Goals & Insights

Gait and Balance
GAIT ↑ 2.6 %   BALANCE ↓ 3.2 %
Gait | Balance
Time (Previous Month)

Weekly Goal
EXERCISE
Wear the insoles at least 15 minutes per day for three days to achieve this goal.

Smart Insoles
CONNECTED ✓
Insoles are connected and calibrated

In the UK, the cost of falls to the NHS is estimated at over £4 billion per annum[1], with the majority of costs due to hip fractures in elderly persons.

Falls are the leading cause for visits to emergency rooms amongst older people, with up to 25% of falls resulting in injury[2].

In the US, over $50 billion is spent annually on medical costs related to falls[2], and these costs continue to rise each year.

Falling can result in pain, injury, loss of confidence, loss of independence and increased mortality. Furthermore, current techniques for assessing fall risk are highly subjective, as they typically rely on qualitative observations of gait and balance by health care professionals.

1. UK Government, Office for Health Improvement and Disparities. Falls: Applying All Our Health. 2022 Feb 25.
2. US Government, Centers for Disease Control and Prevention. Cost of Older Adult Falls. 2020 Jul 9.

Smart, Connected, Accessible

At the core of our solution are smart insoles

While offering the same level of comfort as insoles that can be purchased from your local pharmacy, our smart insoles are equipped with sensors that measure the pressure exerted by different areas of your foot, your acceleration and your rotational velocity. These measurements are recorded a hundred times per second, allowing our system to construct a highly accurate view of your body movement.

At-Home Convenience

Patients place the smart insoles in their favorite pair of shoes – and then forget about them. Every time you go for a walk, your smart insoles collect data on your gait; this data is securely transmitted to the Celestra Health cloud where AI algorithms are applied to gain insights into your walking patterns and balance. Our algorithms establish a baseline for each user, from which we can detect even the slightest changes. In some cases, the user's walking may improve due to physiotherapy and rehab; in other cases, their walking pattern may show signs of deterioration. Celestra Health can even detect walking events such as foot drops and stumbles, or identify specific walking phenotypes (for example, MS patients often exhibit spasticity, due to a tightness in their leg muscles that prevents them from maintaining smooth, controlled limb movements and increases their risk of falling) or detect when the patient is using an assistive walking device.

Specialized Wearable Technology

While smart watches and smart phones are widely used for tracking health and exercise-related data, there are limitations when it comes to tracking walking patterns using a device that is attached to your wrist or is in your back pocket, jacket or knapsack. While Celestra Health makes use of movement data available from your smart watch and/or smart phone (if available) to increase the accuracy of its insights, neither smart watches nor smart phones are able to capture gait data with the same level of accuracy.

Patient's Environment

Smart Insoles

Fall, Balance and Cognitive Assessments

Smartphone Monitoring App

Celestra Health Cloud AI Algorithms

Private Dashboard

Clinical Monitoring & Goal Adjustment

Designed for Everyday Use

At Celestra Health, we have worked closely with patients to ensure our wearable device fits into their lives as seamlessly as possible. Our smart insoles are invisible to others, as they are fully hidden within your shoes. And charging is a snap, as the smart insoles are recharged simply by placing your shoes on a charging tray that uses wireless induction charging. So there are no wires to connect to your insoles, no coin batteries to be pried from your insoles and no need to remove your insoles from your shoes.
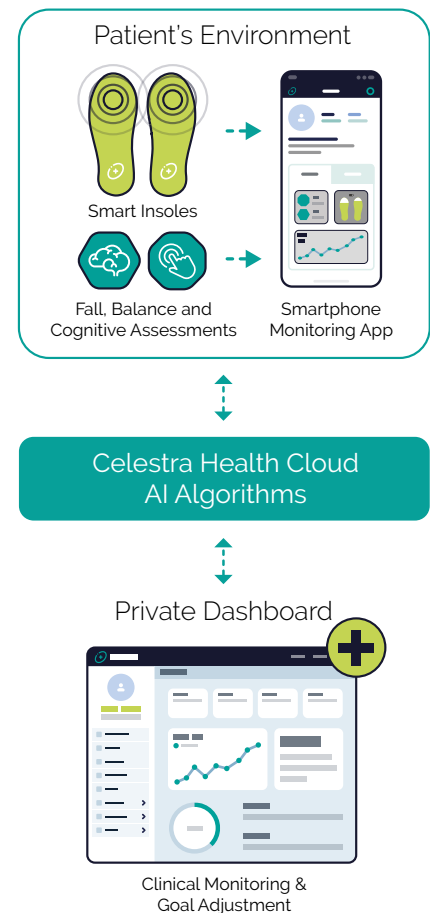
Convenient, Discreet, Accurate

A Highly Effective 'Gait Lab in a Shoe'

For medical conditions such as MS or Parkinson's, patients are sometimes referred to a gait lab, where synchronized high speed video cameras, steel force plates and specialized treadmills are used to accurately measure the patient's gait.

A barrier to collecting laboratory-grade human movement data is that it is expensive, time consuming, and requires highly trained personnel to collect and analyze the data. Whereas the Celestra Health solution unobtrusively collects gait data as the user goes about their daily routines. This approach avoids over relying on a single set of measurements taken on a single day, wherein the data can be easily skewed depending on whether the patient is having a good day or a bad day. By collecting 15-minute walking samples 3x per week, Celestra Health's solution smoothes out any day-to-day variations and thus presents a more reliable and objective measurement of the user's gait and how it is changing over time.

Medical studies have shown that the calibre of data collected by our smart insoles is equivalent to the quality of data that is available from a multi-million-dollar gait lab; we refer to this concept as "gait lab in a shoe". We have designed our solution to be as intuitive and user-friendly as possible, and are continuing to work closely with patients in Europe and North America. We are also working with a world-class team of neurologists from Harvard, Bart's Health (one of the largest NHS trusts in the UK) and The Ottawa Hospital in Canada.

Gait Lab & Smart Insole Comparison

Refer to the table below for a comparison of Celestra Health's measurements of a sample of core gait parameters compared to a "gold standard" gait lab.

Metrics	Celestra Health	Gait Lab	Difference
Step Time	1.19s	1.18s	0.0075s
Stance Time	0.69s	0.69s	0.0128s
Swing Time	0.49s	0.50s	0.0110s
Stance %	58%	58%	0.0096%
Swing %	42%	41%	0.0083%

In conclusion, Celestra Health's medical-grade solution has been designed for ease-of-use and comfort, and uses a state-of-the-art approach for objectively monitoring fall risk in elderly persons and/or patients and provides proactive notifications in the event of increased risk of falling. Current techniques for assessing fall risk are highly subjective, and are heavily reliant on qualitative observations of gait and balance. By notifying users before the fall occurs, preventative measures can be taken in advance, including strength and balance exercise programs, introduction of assistive walking devices and the reduction of safety hazards in the patient's living environment.