The XXXVII$^{th}$ Annual International Occupational Ergonomics and Safety Conference
Orlando, Florida
July 24-25, 2025

# Forensic Analysis of a Walker-Related Fall: Balancing Design, Safety, and Intrinsic Risk Factors

**Dave Fortenbaugh[1], Erick Knox[2], and Steve Smith[2]**

[1] Engineering Systems Inc., 5575 Tech Center Drive, Suite 115, Colorado Springs, CO, 80919

[2] Engineering Systems Inc., 4215 Campus Drive, Aurora, Illinois 60504

Corresponding author's Email: dmfortenbaugh@engsys.com

**Abstract:** Falls among older adults are a major source of injury, disability, and healthcare burden, with nearly one in three adults over the age of 65 experiencing at least one fall annually. While mobility aids such as walkers and rollators are commonly prescribed to mitigate this risk, improper use, poor fit, and device-related issues can inadvertently contribute to fall incidents. This paper presents a detailed forensic analysis of a fall involving a 75-year-old man who sustained a right hip fracture while using a front-wheeled walker with a fold-down seat in his home. The investigation sought to determine whether the deformation of the walker observed after the incident was a cause or consequence of the fall. A comprehensive approach was employed, integrating physical inspection and three-dimensional scanning of the damaged walker and an undamaged exemplar, standardized load testing per ISO 11199-1:2021, and reconstruction testing simulating fall dynamics. Additional review included the user's medical and fall history, product labeling, and the FDA's MAUDE database for adverse event trends. Results demonstrated that the walker met structural performance requirements under prescribed loading conditions, and that damage patterns observed on the subject walker were reproducible only when external lateral forces were applied during a fall. No similar structural failure trends were identified in the MAUDE database. These findings support the conclusion that the walker was structurally sound prior to the incident and that deformation occurred as a result of the fall, not due to latent defect or misuse during normal operation. This case emphasizes the critical need for careful forensic evaluation of mobility aid-related incidents, accounting for both intrinsic user risk factors and device performance. For clinicians, designers, and safety professionals, the study highlights the importance of matching assistive devices to user-specific needs and reinforcing appropriate use to reduce fall-related injuries among vulnerable populations.

*Keywords:* mobility aid, biomechanics, human factors, forensic engineering, fall risk

## 1. Fall Risk in Older Adults and Mobility Aids

Falls among older adults represent a significant public health concern, contributing to substantial morbidity, mortality, and healthcare expenditures. Recent analyses from the National Health and Aging Trends Study show nearly a quarter of community-dwelling adults 65 and older use at least one mobility aid and approximately 10% use multiple devices, while one in four reports at least one fall annually (Gell et al. 2015). The consequences of falls range from minor bruises to serious injuries such as fractures and traumatic brain injuries, with hip fractures being especially debilitating – leading to long-term disability and often a loss of independence. Beyond the physical toll, falls also have profound psychological and social impacts. Many older adults develop a persistent fear of falling, which can lead to decreased activity, further physical deconditioning, and increased risk of subsequent falls in a self-perpetuating cycle. Nationally, the age-adjusted fall-related death rate rose 31% from 2007 to 2016 (Burns & Kakara, 2018).

Mobility aids, including canes, walkers, rollators, and scooters, are commonly prescribed or self-selected by older adults to mitigate fall risk and support independent ambulation. These devices are designed to compensate for impairments in balance, strength, coordination, and gait that often accompany aging and chronic medical conditions. National survey data indicate that approximately 24% of community-dwelling adults over age 65 use at least one mobility device, with nearly 10% reporting the use of multiple devices within a single month (Gell et al. 2015). While these devices can improve mobility and confidence, their use also introduces new challenges and potential hazards. Improper selection, poor fit, lack of training, and mechanical failure can all undermine the intended benefits and, in some cases, increase fall risk rather than reduce it.

Although mobility device use per se is not inherently associated with higher fall incidence when adjusted for health status and demographic factors, the circumstances under which devices are used – and how well they match an individual's physical needs – are critical determinants of safety (Gell et al. 2015). Device misuse, environmental interactions, and latent product defects may all contribute to fall events. These hazards compound well-established intrinsic and extrinsic risk factors,

ISBN: 9781938496639

DOI: https://doi.org/10.47461/ISOES.2025.Fortenbaugh2

such as gait instability, polypharmacy, vitamin insufficiency, vision loss, and home environmental risks (Ambrose et al., 2013; Centers for Disease Control and Prevention, 2017). Therefore, understanding the intersection among human factors, ergonomics, biomechanics, device design, and individual health conditions is essential for both preventing falls and forensically evaluating them after they occur. This paper aims to explore these issues through the lens of a detailed case investigation involving a walker-related fall and to consider the broader implications for mobility aid design, usage, and litigation.

## 2. Case Study Background

A 75-year-old male sustained a right hip fracture after falling in his kitchen while using a front-wheeled walker that had a fold-down seat. At the time of the incident, he was independently mobile within his residence and relied on the walker daily due to multiple comorbidities, including diabetic neuropathy, a history of foot ulcers, and lumbar radiculopathy. These conditions, compounded by recent gait disturbances and pain exacerbations, placed him at elevated risk for falls. Peripheral neuropathy is a complication of diabetes that compromises medial-lateral balance during level walking and stair negotiation, exposing patients to sideways falls (Brown et al., 2015). He had a documented history of prior falls, including at least two incidents resulting in injuries within the three years leading up to the subject event. Elderly adults with a fall history show greater step-to-step kinematic variability, which itself predicts future instability (Barak et al., 2006). Following one such fall, he was prescribed physical therapy to improve balance and walking stability, although he later reported limited adherence to his home exercise program.

Just prior to the subject incident, the man was preparing to feed his dog. He removed a 3.5-pound bag of refrigerated dog food and placed it temporarily on the seat of the walker to carry it to the kitchen counter. After setting the food bag on the counter, he fell, landing on his right side. According to his testimony, he was not moving the walker at the time of the fall and did not recall whether he was standing inside or outside of the walker's frame when it occurred. He did not report attempting to sit or perform any maneuver involving the walker's seat. The fall was unwitnessed, and no security or home surveillance footage was available.

After the incident, the walker was found tipped onto its right side with visible deformation of the front leg tubes and misalignment of the frame. Photographs were taken prior to removal, and the subject walker was retained for inspection. Given the injuries sustained and the apparent physical damage to the walker, questions arose regarding the role of the mobility aid in the fall sequence. Specifically, it was unknown whether the observed damage contributed to the incident, resulted from the fall itself, or reflected a pre-existing defect or maintenance-related issue.

## 3. Forensic Investigation of the Subject Incident

To evaluate the cause of the incident and determine whether the condition of the subject walker contributed to or resulted from the fall, a multi-faceted forensic investigation was conducted using the scientific method as a framework for evaluation (Knox et al., 2015). The approach integrated physical examination of the damaged walker, dimensional analysis through three-dimensional scanning, comparison with an undamaged exemplar, and mechanical testing informed by applicable safety standards. These methods were supported by review of user testimony, medical records, and product documentation to contextualize the findings.

A site inspection was unable to be performed, so the layout of the kitchen and the positioning of the walker at the time of the fall were reconstructed based on the user's deposition testimony. He described retrieving refrigerated dog food and setting it on the walker's seat while maneuvering in the kitchen. After lifting the food bag onto the counter, he fell to his right. The location of this fall, and the positioning of the walker relative to his body, were therefore inferred from narrative descriptions rather than physical measurements or photographs of the scene.

The subject walker, which had been retained after the incident, exhibited visible signs of damage including inward deformation of the left and right front legs and distortion of the lower frame. The unit was documented with high-resolution photography and then scanned using a three-dimensional laser scanner to capture its geometry with sub-millimeter accuracy. An undamaged exemplar of the same model was also scanned using the same protocol. These digital models were overlaid to visualize and quantify deviations in leg positioning, cross-brace orientation, and handle symmetry.

Static load testing was conducted on the exemplar walker to assess its structural performance under conditions representative of typical and atypical use. These tests were based on procedures outlined in ISO 11199-1:2021, the international standard for walking aids with wheels. Loads were applied vertically to the walker frame to simulate downward body weight during seated or supported use, and laterally to the legs to represent off-center or tipping forces. The magnitude and duration of each load followed the ISO protocol. The goal of this testing was to determine whether the deformations observed in the subject walker could reasonably result from a fall or accidental misuse, as opposed to a product failure during normal operation.

To replicate the observed damage pattern and evaluate whether it could result from a fall involving lateral body contact, a reconstruction test was conducted using an undamaged exemplar walker. The walker was positioned on its side such that the legs on one side were supported by the ground while the opposite legs were suspended, mimicking a tipped-over orientation. A controlled, partial-weight fall was performed onto the elevated front leg using human body mass to simulate lateral impact. The resulting deformation of the walker – particularly the inward bending of both front legs – was then compared to that observed on the subject walker. This test provided insight into whether the specific pattern and degree of deformation could occur as a result of external loading during a fall.

To assess whether the incident was part of a broader pattern of similar events, a search was conducted of the U.S. Food and Drug Administration's (FDA's) Manufacturer and User Facility Device Experience (MAUDE) database. This public database captures voluntary and mandatory reports of adverse events and malfunctions associated with medical devices, including mobility aids. The search focused on reports involving the same walker model and product family, using both brand and generic search terms. Relevant entries were reviewed to identify any patterns of structural failure, user instability, or brake-related issues. This contextual data helped inform whether the observed incident characteristics aligned with prior user experiences or represented an isolated occurrence

Finally, the walker's user manual and labeling were reviewed to assess whether warnings, maintenance instructions, or use guidelines adequately addressed foreseeable scenarios such as object transport or lateral loading. The user's medical history and fall history were also reviewed to identify potential intrinsic factors that may have contributed to loss of balance or compromised postural stability.

## 4. Analysis and Findings

To evaluate the structural performance of the walker model, static load testing was performed using procedures outlined in ISO 11199-1:2021. The maximum user weight of the product is 300 pounds. For that capacity, the standard requires a load of 450-468 pounds be applied vertically in an upright in-use orientation. The standard also requires 66-69 pounds be applied to the end of the walker leg in a worst-case cantilever loading orientation without failure. These tests confirmed that an exemplar walker of the same model met the applicable mechanical strength requirements and did not exhibit excessive deformation under the prescribed loading conditions. The results demonstrated that the walker was capable of withstanding normal use forces and even elevated symmetric and lateral loads without structural compromise. This supported the interpretation that the subject walker was not defective or weakened prior to the fall.

The physical inspection and scan data revealed that the subject walker exhibited multiple inward and rearward deformations to its front and rear legs, most notably at the left front leg. When compared to an undamaged exemplar through three-dimensional overlay, these deformations were found to be localized and directional – suggesting that significant external forces were applied laterally and asymmetrically (Figure 1). The pattern of damage was inconsistent with forces that would occur during upright use or even foreseeable misuse while the walker remained upright. Instead, the configuration of the damaged frame pointed to loading from outside the walker's envelope after it had tipped.

A controlled loading fall was conducted to determine whether the damage pattern could be reproduced under plausible fall dynamics (Figure 2). When subjected to lateral impact while tipped, the exemplar walker developed inward bending patterns that closely matched those observed in the subject unit (Figure 3). This finding further supported the hypothesis that the walker's frame was deformed during, not prior to, the incident.

Additionally, a review of the FDA's MAUDE database was conducted to identify any prior reports of similar issues involving the same walker model. While the database included general reports of falls and brake-related concerns, there were no entries describing structural deformation or failure patterns consistent with those observed in this case. This absence of similar reports suggested that the incident was not representative of a broader product defect trend. It also echoes CDC surveillance showing that most fatal fall trajectories involve intrinsic loss of balance rather than catastrophic device failure (Burns & Kakara, 2018).

Taken together, the findings from physical inspection, ISO-compliant testing, controlled reconstruction, and adverse event surveillance point to a scenario in which the walker was structurally sound prior to the incident and was damaged as a result of external loading during the fall. The user's elevated fall risk, combined with deviation from intended use, likely contributed to the dynamics of the event.

Figure 1. Overlay of the subject walker geometry (dark grey) with an undamaged exemplar walker (blue)

Figure 2. Controlled loading fall onto exemplar walker laying on its right side

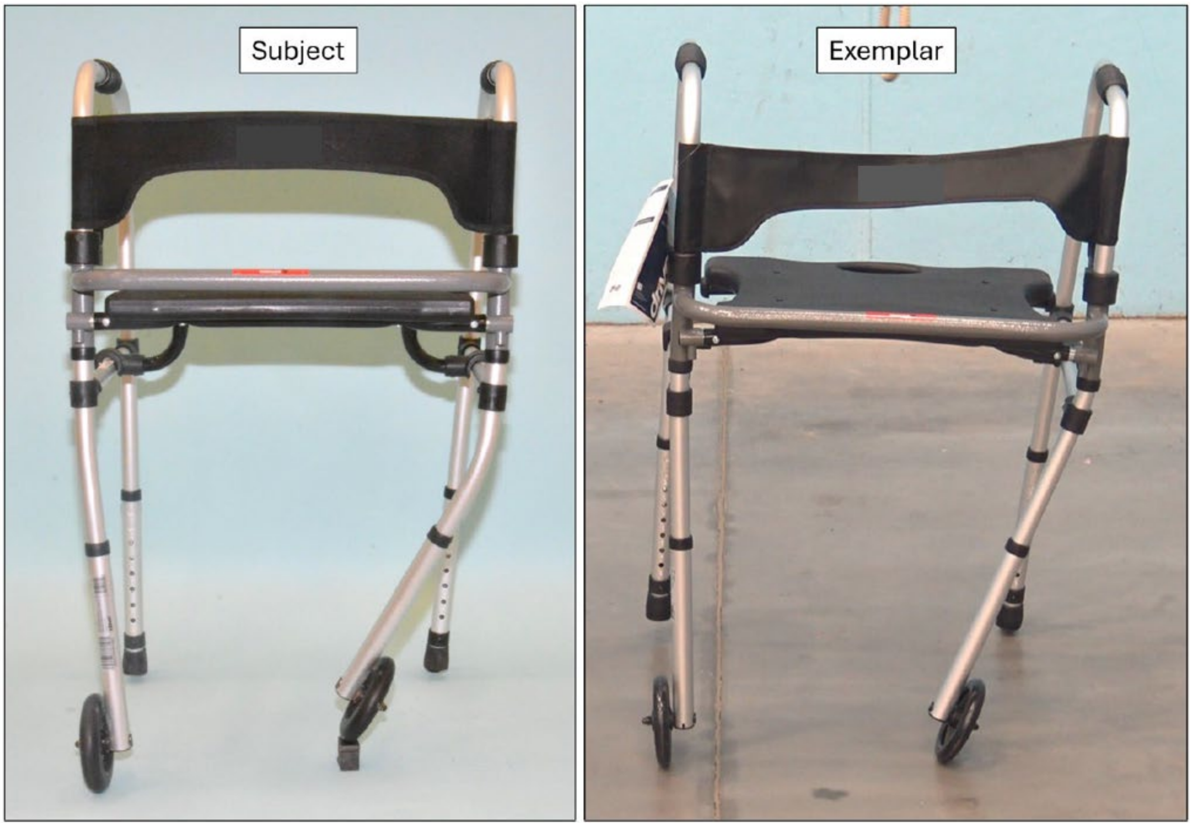


Figure 3. Comparison of damage between the subject walker and the exemplar struck in the controlled loading fall

## 5. Conclusions and Broader Implications

The investigation concluded that the walker involved in the incident was structurally sound prior to the fall and did not exhibit signs of latent defect or mechanical failure. The deformation observed in the frame – particularly the inward and rearward bending of multiple legs – was determined to have resulted from external loading during the fall event, not from a collapse or malfunction under normal use. This conclusion was supported by detailed scan comparisons, standardized load testing in accordance with ISO 11199-1:2021, and physical reconstruction of the damage using an undamaged exemplar walker. Further, a review of adverse event data did not reveal a pattern of similar structural issues associated with this walker model. Together, these findings provided a consistent body of evidence indicating that the walker did not cause the fall but was instead damaged as a consequence of it.

This incident underscores the reality that individuals who rely on mobility aids represent a population with known impairments in gait, balance, and postural stability. While these devices are essential for maintaining independence and mitigating fall risk, their effectiveness depends on proper selection, correct usage, and recognition of their functional limits. In this case, multiple intrinsic risk factors – such as neuropathy, lower limb weakness, and prior fall history – were present and likely contributed to the individual's loss of balance.

For investigators, clinicians, and safety professionals, this case highlights the importance of a multidisciplinary approach in understanding falls involving assistive devices. Integrating physical evidence, performance testing, and user-specific health considerations enables a more accurate assessment of causality and risk. For caregivers and prescribers, the findings reinforce the value of regular reassessment, patient education, and awareness of how even routine activities of daily living – like feeding the dog – can increase the likelihood of an adverse event.

Ultimately, while mobility aids play a critical role in promoting autonomy and stability, they cannot fully eliminate the risk of falling – especially in medically complex individuals. A comprehensive strategy that includes environmental evaluation, strength and balance training, and close attention to individual user needs remains essential in reducing fall-related injuries in vulnerable populations.

## 6. References

Ambrose, A. F., Paul, G., & Hausdorff, J. M. (2013). Risk factors for falls among older adults: A review of the literature. Maturitas, 75(1), 51–61. https://doi.org/10.1016/j.maturitas.2013.02.009

Barak, Y., Wagenaar, R. C., & Holt, K. G. (2006). GAIT Characteristics of Elderly People with a History of Falls: A Dynamic approach. Physical Therapy, 86(11), 1501–1510. https://doi.org/10.2522/ptj.20050387

Brown, S. J., Handsaker, J. C., Bowling, F. L., Boulton, A. J., & Reeves, N. D. (2015). Diabetic peripheral neuropathy compromises balance during daily activities. Diabetes Care, 38(6), 1116–1122. https://doi.org/10.2337/dc14-1982

Burns, E., & Kakara, R. (2018). Deaths from Falls Among Persons Aged ≥65 Years — United States, 2007–2016. *MMWR Morbidity and Mortality Weekly Report*, *67*(18), 509–514. https://doi.org/10.15585/mmwr.mm6718a1

Centers for Disease Control and Prevention. (2017). *Risk factors for falls*. https://www.cdc.gov/steadi/media/pdfs/STEADI-FactSheet-RiskFactors-508.pdf

Gell, N. M., Wallace, R. B., LaCroix, A. Z., Mroz, T. M., & Patel, K. V. (2015). Mobility Device Use in Older Adults and Incidence of Falls and Worry About Falling: Findings from the 2011–2012 National Health and Aging Trends Study. *Journal of the American Geriatrics Society*, *63*(5), 853–859. https://doi.org/10.1111/jgs.13393

ISO 11199-1, (2021). International Standard – Assistive Products for Walking Manipulated by Both Arms – Requirements and Test Methods – Walking Frames. *ISO11199-1:2021.*

Knox, E. H., Mathias, A. C., Stern, A. R., Bree, M. P. van, & Brickman, D. B. (2015). METHODS OF ACCIDENT RECONSTRUCTION: BIOMECHANICAL AND HUMAN FACTORS CONSIDERATIONS. Proceedings of the ASME 2015 International Mechanical Engineering Conference and Exposition, 1–11. Moylan, K. C., & Binder, E. F. (2007). Falls in Older Adults: Risk assessment, management and Prevention. *The American Journal of Medicine*, *120*(6), 493.e1-493.e6. https://doi.org/10.1016/j.amjmed.2006.07.022