



## Brief Report

## Dual-Stiffness Flooring: Can It Reduce Fracture Rates Associated With Falls?

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## A B S T R A C T

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**Objective:** Falls cause significant morbidity and mortality in long term care facilities. Dual-stiffness flooring (DSF) has previously shown promise in reducing such morbidity in experimental models. This study set out to measure the impact of SmartCell flooring on falls-related morbidity in a nursing home. **Methods:** All falls occurring at an Arizona nursing home between July 1, 2008, and December 31, 2010, were reviewed for age, sex, diagnosis of osteoporosis, number of medications, history of previous falls, type of flooring (normal vs DSF), time of day, type of injury, and resulting actions. Fall-related outcomes were compared across room types using chi-square and logistic regression methods.

**Results:** Eighty-two falls on the DSF were compared with 85 falls on the regular floor. There was a tendency for residents falling on DSF to have less bruising and abrasions, while having more redness and cuts. There were 2 fractures on regular flooring (2.4% fracture rate) and none on the DSF flooring (0% fracture rate).

**Conclusions:** The fracture rate of 2.4% of falls on the regular floor is consistent with previous reports in the literature, whereas a 0% rate found on the DSF floor is a clinically significant improvement. This suggests that DSF may be a practical approach for institutions and consumers to reduce fall-related injuries. A larger scale controlled study to confirm these encouraging preliminary findings is warranted.

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Falls in older adults are associated with significant morbidity and mortality. Older adults living in nursing homes are three times as likely to fall as those living in the community. Rapp et al<sup>1</sup> estimated the rate of falls to be about 1.6 per nursing home bed per year. Falls in this population lead to fractures approximately once every 20 falls.<sup>2,3</sup> Beyond the significant impact falls have on the resident, falls with injury are also responsible for about 60% of liability cases filed against nursing homes.<sup>4</sup>

Since 1988, numerous studies have suggested that the wearing of hip protectors can reduce the fracture rates related to falls.<sup>5,6</sup> A recent Cochrane review, however, found only a marginally significant reduction in hip fracture risk in the use of hip protectors in nursing homes, but not in the community.<sup>7</sup> Furthermore, compliance with the wearing of hip protectors is not very high.<sup>8</sup>

An alternative approach to having each resident wear a hip protector could be to design a safer floor. Dual-stiffness flooring (DSF)

has a rigid top layer and a collapsible lower layer (Figures 1 and 2). The intent is that the top layer provides support like a regular floor, while the collapsibility of the lower layer acts as a shock absorber. A number of biomechanical studies have suggested that DSF diminishes the impact of contact with a floor, potentially reducing injuries associated with falls.<sup>9,10</sup> More recent studies have further supported these findings in people.<sup>11,12</sup> Given that about 75% of falls in a nursing home occur in residents' rooms, including the bathroom,<sup>1</sup> it would make sense to install DSF in residents' rooms. To our knowledge, there are no publications to date from a controlled study comparing injury rates on regular flooring with that on DSF in a nursing home setting.

## Methods

The research protocol for this study was approved by the Bruyère Research Ethics Board on May 25, 2010. The Bruyère Research Ethics Board did not feel that written consent from each resident was necessary because (1) the data were collected retrospectively from incident forms that were collected as part of normal quality improvement activities, (2) there was no change in care being

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### SmartCells get softer as they are compressed.

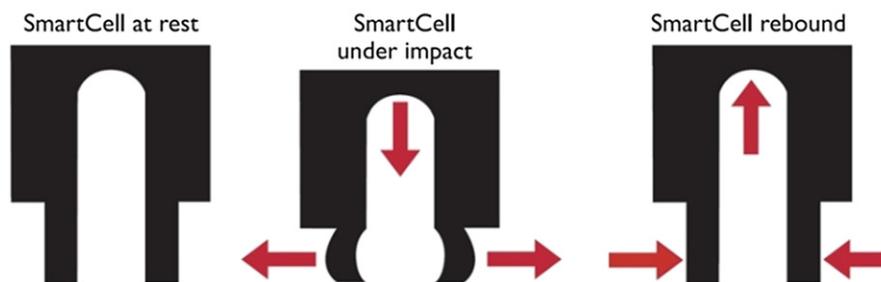


Fig. 1. SmartCell flooring model showing impact characteristics.

provided to individual residents as part of the protocol, and (3) the information was de-identified at the nursing home. The research protocol was also approved by the management of the nursing home.

Mountain View Manor is a 116-bed skilled nursing facility in Prescott, Arizona, providing residential, rehabilitation, and palliative care. Two resident bedrooms and bathrooms in the rehabilitation section have DSF flooring (SmartCells flooring) installed. Residents assessed with high risk of fall are selected to stay in these rooms.

Like most nursing homes, Mountain View Manor tracks fall incidents using a standard form that collects date/time and location of fall, consequences of the fall for the resident, contributing factors, and the care plan. Copies of this form are kept by the director of nursing. In 2010, after obtaining institutional review board approval, management supplied two auditors who completed audit forms providing details regarding age, sex, osteoporosis, number of medications, previous falls, type of flooring (normal vs DSF), time of day, type of injury, and resulting actions. Looking at the 2009 data, it was determined that there were approximately three times as many falls on regular flooring than on the DSF, so it was agreed to use data from every third fall on regular flooring (chronologically). Furthermore, it was decided to augment the retrospective data for the period of July 1, 2008, to December 2009 with prospective data from January 1 to December 31, 2010.

Injury rate and type comparisons based on chi-square analyses, and prediction of room type allocation based on the number of injuries sustained using logistic regression, were conducted.



Fig. 2. Photograph of SmartCell flooring showing detail and typical covering.

## Results

Over the study period, there were 449 documented falls. There were 82 falls on the DSF, and these were compared with the first 85 identified by taking every third of the remaining 282 falls on regular flooring. Fallers had a mean age of 74.2 years; 53% were male and 24% were on medication for osteoporosis. On average, these patients took 10 medications. Fifty-five percent of falls resulted in an injury and 26% in a significant injury, defined as abrasion, cut, fracture, or two or more injuries (Table 1). Patients allocated to DSF flooring rooms were comparable with their counterparts in the regular flooring rooms on the previously mentioned factors except that they were significantly younger and took significantly fewer medications; these factors were thus treated as covariates in the analyses. There was a marked tendency for residents falling on DSF to have less bruising and abrasions while having more redness and cuts. There were two fractures on regular flooring (2.4% fracture rate) and none on the DSF flooring (0% fracture rate).

## Discussion

Although a number of studies have shown that flooring can affect fall outcome, and Drahotka and colleagues<sup>13</sup> are planning a pilot cluster randomized controlled trial, we believe this is the first completed study of the impact of flooring on injury outcome in a nursing home. The 2.4% fracture rate on the regular floor in this study is consistent with a number of incidence reports in the literature, whereas the 0% fracture rate on the DSF floor is a clinically significant improvement over prior reported results. In addition, the tendency for residents falling on DSF to have less bruising and abrasions is encouraging. On the other hand, the trend toward increasing redness and cuts is unexpected. One explanation could be that some of the increased redness from falls on the DSF is related to the reduced bruising, suggesting that a given fall may result in a bruise on a regular floor while resulting in redness on a DSF. The

Table 1  
Injury Pattern

Falls and Type of Injury	Dual-stiffness Flooring	Regular Floor
No. of falls	82 (49%)	85 (51%)
No. of falls with injury	44 (53%)	48 (56%)
Redness	2.4%	1.2%
Bruise	2.4%	7.1%
Abrasion	9.8%	15.3%
Cut	13.4%	9.4%
≥2 injuries	1.2%	1.2%
Fracture	0.0%	2.4%
Other	2.4%	2.4%

mechanism for obtaining cuts while falling is likely related to impact with wall, bed, wheelchair, or other environmental structure before impact on the floor. This would need to be verified with further studies, but suggests that flooring adjustment is but one component of environmental modifications required.

Both clinical findings and preliminary statistical trends analysis suggest a positive effect of dual-stiffness flooring. This suggests that DSF may be a practical approach for institutions and consumers to reduce fall-related injuries. In contrast to other mechanical solutions, like hip protectors, DSF requires no active client participation and hence is always “on.”

Although a number of trends were identified, there was insufficient power to attain statistical significance. In addition, there was no randomization for assignment to DSF rooms, as patients with high risk of fall were selected for these rooms. Further research based on a large and controlled study to confirm these encouraging preliminary findings is warranted.

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