S. ROBINOVITCH (Convener). Technology for the prevention of fall-related injuries among older adults living in long-term care. Gerontechnology 2010;9(2):163; doi:10.4017/gt.2010.09.02.102.00 **Participants**: *S. ROBINOVITCH (CANADA), F. FELDMAN (CANADA), E. PARK (CANADA),* and *J. SIMS-GOULD (CANADA).* **ISSUE** Falls are the primary cause of injuries and injury-related deaths in older adults, and are especially common in long-term care (LTC) facilities. Two barriers to the prevention of these events are: (i) the need to develop technologies (such as wearable sensors and video-based networks) for providing objective, real-time data on the cause and circumstances of these events; and (ii) the need to develop, implement, and evaluate improved technologies (such as compliant flooring and active wearable hip protectors) for reducing the risk for injury in the event of a fall. Speakers will describe our team's multi-disciplinary efforts to address these issues. **STRUCTURE** Funded in 2009 by a five-year grant from the CIHR Mobility in Aging program, our team draws together university researchers, government agencies and end users for the development of innovative technologies to prevent falls and fall injuries (especially hip fractures) in older adults. Our efforts involve an integrated set of research and demonstration projects in long-term care (LTC) living facilities in the Fraser Health region. The goal of this symposium will be to inform and engage audience members in dialogue on our preliminary results and methodology, and applications of technology in fall injury prevention. **CONTENT** Stephen Robinovitch will discuss preliminary results on the cause and characteristics of real-life falls as captured on networks of digital video cameras in LTC. Fabio Feldman will provide an update on the use of force-attenuating compliant flooring and hip protectors in preventing fall-related injuries in LTC. Ed Park will discuss the use of wearable sensors to accurately detect falls, and distinguish fall mechanisms. Joanie Sims-Gould will discuss mechanisms for involving community partners and policy-makers in the design, implementation and evaluation of fall injury prevention technology in LTC. **CONCLUSION** Technologies such as video capture, wearable sensors, compliant flooring, and hip protectors have the potential to enhance our ability to prevent falls and fall injuries in LTC. This symposium will present a proposed framework, and facilitate audience involvement in defining future priorities, for the development and application of this technology.

Keywords: injury prevention, falls, video capture, wearable sensors, LTC

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S.N. ROBINOVITCH, E. ROBINSON, Y. YANG, T. SARRAF, O. AZIZ, M. JALILI, M. LUENG, M. LOUGHLIN, F. FELDMAN. Video capture of the causes and activities associated with real-life falls among older adults residing in long-term care. Gerontechnology 2010;9(2):163-164;
doi:10.4017/gt.2010.09.02.103.00 **Purpose** Falls are the most common cause of injury in older adults. Yet most falls are unwitnessed and self-recall of these events is often unreliable[1,2]. Accordingly, we have little understanding of the true cause and circumstances of falls and how these associate with physiological and environmental factors. Over the past two years, we have worked with two LTC facilities to collect video footage of 184 real-life falls occurring in common areas (for instance, dining rooms, hallways). In this preliminary report, we analyze these data to determine the most common causes and activities associated with falls. **Method** An expert team (of at least 3 individuals) used a structured questionnaire to determine the cause and circumstances of each fall captured on video. Cause of fall was categorized

into slip, trip or stumble, hit or bump, collapse, incorrect transfer or shift of body weight, and loss of support with external object. Activity at the time of the fall was categorized into sitting down or lowering, seated or wheeling in wheelchair, getting up or rising, walking forward, walking backward or sideways, walking and turning, initiation of walking, standing quietly, and standing and turning. For hypothesis testing, we used generalized linear models to probe for differences in the proportion of residents experiencing at least one fall due to the various causes, and while performing each activity. We examined both unadjusted p-values (α=0.05) and p-values adjusted to account for multiple comparisons. **Results & Discussion** The most frequent causes of falls were incorrect transfer or shift of body weight (mean proportion=51%; SE=6%), trip or stumble (mean=22%; SE=5%), hit or bump (mean=21%; SE=5%), and loss of support with external object (mean=13%; SE=4%). The proportion of residents falling at least once due to incorrect transfer or shift of body weight was larger than for any other cause (adjusted p<0.005). Furthermore, the proportion of residents falling due to slipping was smaller than for trip or stumble (adjusted p=0.03), and hit or bump (adjusted p=0.05). The most frequent activities at the time of fall were walking forward (mean proportion=26%; SE=5%), standing quietly (mean=22%; SE=4%), sitting down or lowering (mean=16%; SE=4%), and getting up or rising (mean=13%; SE=4%). The proportion of residents ever falling while walking forward was greater than while seated/wheeling in wheel chair (adjusted p=0.03), getting up or rising (p=0.03), walking backward or sideways (p=0.003), walking and turning (p=0.03), standing and reaching (p=0.009), or standing and turning (p=0.005). However, falls were just as likely to occur while standing quietly, sitting down or lowering, or during initiation of walking, as during steady forward walking. Furthermore, the proportion falling while standing quietly was greater than while standing and reaching (p=0.05), or standing and turning (p=0.03). Based on analysis of 184 video-captured falls in two LTC facilities, the most common cause of falls was incorrect transfer or shift of body weight, which accounted for more than one-half of cases, and was twice as frequent as the next most common cause (trip or stumble). There was no significant difference in the frequency of the four most common activities associated with falls, which were forward walking, standing quietly, sitting down or lowering, and initiation of walking. These results challenge current assumptions regarding the cause and prevention of falls in older adults residing in LTC.

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Keywords: falls, mobility, hip fracture, head injury, video capture, mechanisms, long-term care
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F. FELDMAN, A.C. LAING, S.N. ROBINOVITCH. Update on compliant flooring and wearable hip protectors for fracture prevention in long-term care. Gerontechnology 2010;9(2):164-165; doi:10.4017/gt.2010.09.02.104.00 **Purpose** Hip fractures are a global health concern degrading quality of life for their sufferers. Over 90% of hip fractures occur from falls[1]. Wearable hip protectors (padded undergarments) and compliant flooring represent promising strategies to decrease impact force and fracture risk. Hip protectors reduce femoral force impact by either decreasing the stiffness of the contact site (greater trochanter), or by forming a bridge over the trochanter to shunt the energy to the surrounding soft tissue. However, clinical trials have yielded conflicting results on the effectiveness of existing hip protectors[2]. This likely results from poor compliance among users in wearing the device (often less than 50%[3]) and the results from biomechanical studies showing that most available hip protectors reduce the force applied to the proximal femur by less than 30%[4]. These two issues can be addressed by the design of a rapidly deploying 'airbag-like' inflatable device, which should provide much greater force attenuation while maintaining a much slimmer profile when uninflated. An alternative to hip protectors is to reduce the stiffness of the floor. This passive intervention requires no decision on the part of the user and, as such, compliance is 100%. However, large reductions in floor stiffness would likely be counter-productive due to their negative effects on gait and bal-

ance. **Method** Biomechanical tests using a mechanical hip impact simulator, which mimics a sideways fall by an older woman, demonstrated that purpose-design compliant flooring can reduce the force applied to the proximal femur during a fall by up to 50%[5]. Yet, very few long term care facilities have flooring designed to reduce the impact of a fall. **Results & Discussion** This presentation will provide an update on the use of hip protectors and compliant flooring in preventing fall-related injuries in long-term care. It will also provide data from biomechanical testing of commercially available hip protectors and compliant flooring.

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O. AZIZ, K,J. LEE, S.N. ROBINOVITCH, E.J. PARK. Capturing the cause and circumstances of falls through wearable sensors. Gerontechnology 2010;9(2):165-166; doi:10.4017/gt.2010.09.02.105.00

Purpose Falls are the number one cause of injury in older adults. Wearable sensor arrays (for instance, accelerometers) represent a promising technique for determining the cause and circumstances of falls in high-risk individuals. Previous studies have shown that the occurrence of a fall can be sensed reliably from the high acceleration generated at impact. This study extends this research by developing and evaluating a sensor array system for determining the cause of a fall. As an essential first step in this process, this study examines how the location and number of acceleration sensors influence the accuracy of the system in differentiating three separate types of falls acquired in the laboratory (slip, trip, other collapse). We also discuss current research for monitoring gait stability with wearable sensors. **Method** 16 young, healthy individuals with ages ranging from 20 to 35 years participated in trials involving falls due to slips, trips, and 'other' causes. 3D position data were collected at 120 Hz from markers at the head, sternum, waist, and feet, and differentiated to estimate accelerations. The means and variances of the X, Y and Z accelerations of each marker for the 1500 ms prior to pelvis impact were input to a linear discriminant model for fall type classification. **Results & Discussion** The sensitivity of the classification algorithm depended strongly on the location and number of markers and varied considerably between different types of falls. Accelerations data from just three locations (for instance, the two feet and the sternum) provided at least

Table 1. Sensitivity of sensor arrays in detecting the cause of falls

Marker combination	Sensitivity, %		
	Slips (n=48)	Trips (n=48)	Other (n=144)
Head	79	52	85
Sternum	79	31	92
Waist	96	52	96
Left foot + right foot	79	92	90
Waist + sternum	100	54	98
Waist + head	96	56	97
Sternum + head	89	71	92
Left foot + right foot + waist	96	89	98
Left foot + right foot + sternum	96	96	96
Left foot+ right foot + head	96	87	96
Waist + sternum + head	94	58	97
Left foot + right foot + waist + sternum	94	94	98
Left foot + right foot + waist + head	94	89	98
Left foot + right foot + head + sternum	96	89	97
Right foot + left foot + waist + head + sternum	94	92	97

96% sensitivity in classifying the three types of falls. Note that the feet are associated with gait (lower body) and the sternum can represent the trunk motion (upper body), allowing us to capture the whole body biomechanics. In fact, rather than simple accelerometers, inertial sensors can provide more abundant biomechanical information (e.g. spatio-temporal gait parameters[1] and trunk posture[2]) which are required to better understand the cause and circumstances of falls. Also, our preliminary results, for gait event detection using two ankle-based inertial sensors, showed the capability of estimating gait characteristics such as walking speed, step length and step width. Previous studies have associated these characteristics with risk for falls[3]. Therefore, our future study is to utilize miniature inertial sensing technology to characterize postural stability during daily activities and capture the exact cause and circumstances of falls in an ambulatory fashion. It is important to note that the assessment of risks for falls as a long-term goal is a very complex task, relying on more than gait stability.

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J. SIMS-GOULD, V. SCOTT, H. MCKAY. Barriers and facilitators to the adoption of fall injury prevention technology in long-term care. Gerontechnology 2010;9(2):166;
doi:10.4017/gt.2010.09.02.106.00 **Purpose** In the last decade, knowledge translation and exchange (KTE) has become a cornerstone of successful and effective health research programs[1]. As an essential first step to KTE, stakeholders, end users and decision makers must be actively engaged in the research process. Thus, we outline strategies to identify and engage stakeholders in a large study examining the use of new technologies to prevent falls and fall-related injuries in long term care (LTC) in British Columbia, Canada. **Method** We conducted five focus groups (n=24 participants) with stakeholders (patients, their families and LTC facility staff) associated with two LTC facilities to identify barriers and facilitators to the uptake of new technologies. **Results & Discussion** Based on a thematic analysis of transcripts, preliminary findings suggest that residents of LTC facilities are receptive to new technology but have concerns about the impact on their comfort, appearance and ease of use. Family members and LTC facility staff indicated that for uptake of technologies, such as wearable sensors that register a fall, appearance, ease of use and durability are key. From this starting point, we discuss factors that are central to successful implementation of KTE strategies in similar settings.

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