Until now, information about how and why falls occur among the elderly has been scant. Observational studies by Dr Stephen Robinovitch are helping to fill gaps in the evidence base.

How common are head injuries?
We’re seeing that more than 30 per cent of falls involve head impact. This is really alarming. However, it is in line with evidence that 60 per cent of traumatic brain injuries in seniors are caused by falls. By carefully analysing the video footage, we can identify the factors that separate falls that result in head impact from those that do not, including the direction of the fall and the role of the upper limbs in arresting the fall.

What are the challenges associated with designing interventions for fall prevention?
Preventing falls in older adults is challenging since there are so many established risk factors that often coexist. These include poor muscle strength, use of specific medications and cognitive impairment. We need to take a holistic approach to prevention. Another barrier is the lack of objective information on the circumstances of falls: how and why they occur. What activity was the person engaged in at the time of falling? How did the person lose their balance? These are important questions – which TIMPS is addressing - for the design of improved tools for risk screening, assistive devices and safe movement environments.

Could you elaborate on how inertial measurement units are used in your research?
Wearable sensors are rapidly becoming miniaturised and can provide detailed information on mobility, balance and activity levels in daily activities. They can also be used to track how these outcomes are affected by interventions such as exercise programmes or medication changes. Finally, they can be used to detect falls, alert care providers to these events and provide information on the cause and circumstances. We are working to develop software and hardware to help realise these applications.

One of your goals is to identify novel interventions such as compliant flooring and wearable hip protectors. Can you discuss your findings?
We should clarify that the goal of these technologies is not to prevent the fall but to prevent injury. Wearable hip protectors are a promising strategy but there are two important barriers that we are addressing. The first is improving user compliance. This includes designing products that are comfortable, attractive and easy to use. It also involves addressing independence issues among older adults, and improving staff commitment to their use in a long-term care setting. The second is biomechanical performance and ensuring the device reduces the force applied to the bone enough to prevent hip fracture.

Have there been any important collaborators in your work?
An essential collaborator is Dr Fabio Feldman, Manager for Falls and Injury Prevention at Fraser Health Authority. Fabio’s involvement has been crucial in translating our efforts from the lab into the clinical environment and drawing the participation of other stakeholders via his role, reputation and personal contacts. Another key collaborator is Dawn Mackey, Assistant Professor in the Department of Biomedical Physiology and Kinesiology, Simon Fraser University. Mackey is an epidemiologist and biomechanician who heads our compliant flooring clinical trial.

Firstly, could you introduce your research and outline its main objectives?
Improving our understanding of the causes of falls and fall-related injuries in older adults, and exploring means of prevention are important goals. I address this through several inter-related efforts. I use networks of digital video cameras and wearable sensors to monitor mobility and capture objective evidence on how and why falls occur in older adults. In laboratory studies, I examine how the forces applied to the body during falls compare to those required to cause bone fracture or head injury. I am also designing interventions such as compliant flooring and wearable hip protectors to reduce impact forces to safe levels.

Are elderly trips and falls commonplace? What are the most frequent causes?
Falls are very common: more than 30 per cent of older adults living in the community and 60 per cent living in residential care will fall at least once per year. Our results, published earlier this year in The Lancet, and based on the analysis of video footage of 227 real-life falls in 130 older adults in long-term care, show that the most frequent cause of imbalance is incorrect weight shifting, which accounts for more than 40 per cent of falls. This represents an ‘internal perturbation’ to balance, due, for example, to a poorly placed step during walking, or lack of postural control while sitting down or rising, which causes the body’s centre of mass to move outside of the base of support provided by the feet. Trips and loss of support from an external object are also common. Slips account for very few falls – less than 2 per cent.
FOR MOST OF the 20th century, people over the age of 65 made up only a small proportion of overall Canadian population. However, low fertility rates, longer life expectancy and the effects of the baby boom generation have contributed to an ageing population. According to government statistics, the number of elderly people in the country is projected to double from 5 million in 2011 to more than 10 million by 2036.

Among this demographic group, falls are one of the top 10 causes of death, just behind cardiovascular disease and cancer. In addition, falls are the number one cause of injury among senior citizens. Such injuries can affect an older person’s confidence and mobility, and also have an impact on their independence within the community. Perhaps the most devastating injuries caused by falls among elderly people are hip fractures: in these cases 25 per cent of patients die within one year, while 50 per cent of sufferers experience a major loss of independence.

REAL-LIFE LABORATORIES

For the past 30 years, a great deal of research has been conducted on the cause and prevention of falls in elderly people. However, according to Dr Stephen Robinovitch, who leads the Technology for Injury Prevention in Seniors (TIPS) programme at Simon Fraser University (SFU), a lack of understanding of the circumstances surrounding these events has been a major barrier to prevention.

Most falls are unwitnessed, and according to self reports, slips and trips are the main causes. However, TIPS research based on the analysis of video footage of real-life falls in the long-term care setting, published in The Lancet in January 2013, shows that fewer than 2 per cent of falls among elderly people are hip fractures: in these cases 25 per cent of patients die within one year, while 50 per cent of sufferers experience a major loss of independence.

The research side of the TIPS programme is based at the Department of Biomedical Physiology and Kinesiology and the School of Engineering Science at SFU, and includes an impressive range of biomechanists, engineers, computer scientists, ergonomists, kinesiologists, epidemiologists, neuroscientists, physicians, physiologists and experts in knowledge translation. A particularly interesting element of the TIPS project is the way it combines experiments carried out at the science laboratories of SFU with field studies at two local long-term care facilities in Delta and New Westminster, British Columbia – participate in the TIPS project as ‘real-life’ laboratories, evaluating and refining the technologies developed by Robinovitch and his team in the lab.

The TIPS investigators have installed digital video cameras in common areas, including dining rooms, lounge areas and hallways at both partner care facilities. When a resident falls, the staff complete an incident report and the researchers collect the video data for analysis. An expert team uses a structured questionnaire to review each fall, probing the initiation, descent and impact stages of the event, along with situational and environmental aspects. In addition to examining the cause of imbalance and type of activity at the time of the fall, they look at protective responses (eg. attempts to recover balance) and the occurrence of impact to vulnerable sites such as the head, hip and hands. The group then link these results to clinical datasets in exploring the underlying mechanisms and causes of these events.

This unique university-community partnership is also developing wearable sensors to detect and record falls. Moreover, they are examining two interventions to reduce the injury potential of falls: wearable hip protectors and compliant flooring for high risk environments.

BACK TO THE PLAYGROUND

Robinovitch sees no reason why long-term care facilities for older people should not use the same ‘passive protection’ applied in other high-risk environments: “Playgrounds represent a useful model,” he reflects. However it is important that a compliant
TECHNOLOGY FOR INJURY PREVENTION IN SENIORS (TIPS)

OBJECTIVES
To utilise innovative technologies (such as wearable sensors and video-based networks) to record movement patterns during real-life falls in older adults and provide objective evidence of the cause and circumstances of these events, and to develop and evaluate novel interventions (such as compliant flooring and active wearable hip protectors) to reduce the risk for injury in the event of a fall.

KEY COLLABORATORS
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Technology for injury prevention in seniors

A WEARABLE FALL MONITORING SENSOR

floor layer is not too soft, as this could impair the balance of an elderly person. Laboratory studies by the SFU team have shown that a one-inch thick compliant floor layer does not disrupt the balance of elderly people, but reduces force to the hip during a fall by 35 per cent and to the head by 70 per cent. "We are now embarking on a clinical trial in long-term care to determine whether this product reduces fall-related injuries in care facilities," Robinovitch reveals.

Previous clinical trials have already showed that wearable hip protectors can reduce hip fractures by up to 50 per cent. However, low user compliance is a problem, which has led some manufacturers to sacrifice a certain amount of biomechanical performance for a device with a more slender and aesthetic profile. Residents at long-term care facilities often feel they do not need or want hip protectors and this suggests the need for strategies to raise awareness about the benefits of such devices.

Robinovitch is a member of international standards committees for hip protectors and compliant flooring, a fact that he believes contributes positively to his field of research: “Both of these technologies are in their infancy, and developing standards for product design and testing is essential for market regulation. My participation as a member on these committees allows me to share expertise with other researchers and clinicians as well as stakeholders from both industry and government”.

COMMUNITY SPIRIT
In addition to developing new knowledge and technologies, the TIPS team wants to create greater awareness and translate their results into improved fall injury prevention at the local, national and international levels. To this end, the programme’s research planning involves residents, staff and administrators at the two partner long-term care facilities.

Robinovitch emphasises the need for both traditional and non-traditional approaches to knowledge exchange. For example, he recently delivered a keynote lecture to the International Society for Posture and Gait Research in Akita, Japan, and also organised a symposium at the 20th World Congress of the International Association for Gerontology and Geriatrics in Seoul, Korea. Furthermore, TIPS undertakes collaborations with the FARSEEING research network in Europe, which focuses on promoting healthy, independent living for older adults through fall prevention, as well as at home in Canada.

Moreover, through a supplementary Knowledge Transition grant from the Canadian Institutes of Health Research (CIHR), the group recently developed an educational video on fall injury prevention among the older population for nurses and care workers involved in long-term care. The video incorporates sequences of actual falls as powerful case studies, along with expert commentaries on best practices and new results from TIPS. Robinovitch hopes the video will “convey awareness of the opportunities, and recognition of the challenges involved in preventing falls and fall-related injuries in long-term care”.

Through this combination of innovative experimental and applied efforts, the TIPS project looks set to contribute to a reduction in the frequency and burden of falls among elderly people in Canada and worldwide.