

Evaluation and Integration of an Automatic Fall Prediction System

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Summary: Falls among the elderly are a significant cause of morbidity, mortality, and increased end-of-life health care costs. Reducing the occurrence of falls can greatly improve patients' quality of life. This study developed and evaluated a method to track variability in everyday movements as an additional means to predict risk of falls for elderly residents in assisted living facilities (ALF). It aimed to demonstrate that increased movement variability is a stronger predictor of fall risk than two other well-known risk factors—history of falls and use of prescribed psychoactive medications—and that collectively, prediction of fall risk is significantly improved. Dr. Kearns and his research team anticipated that the new method will be a useful tool for relating changes in fall risk to alterations in health and medications. The tool has been patented and commercial venture initiated to distribute the technology internationally.

This project recruited 53 volunteer residents of two ALF facilities. Baseline standardized gait and balance (SGB) assessments were completed. The velocity, distance, duration, and changes in direction during the volunteers' daytime movements in common areas of congregate living settings were tracked over 12 months by a movement tracking system (MTS) via ultra-wideband active tag radio frequency identification devices. Prospective and retrospective fall histories were evaluated to determine the relationship of SGB and a measure of movement variability called Fractal D path tortuosity (Fractal D), derived from MTS data using software created for this project. Fractal D is a measure of deviation from a straight line of travel.

During the study, a complete evaluation of participant medications was conducted, with particular emphasis on identifying and recording the number of psychoactive and non-psychoactive medications that each participant was prescribed. Each participant's activities of daily living (ADL) status was measured at time of enrollment and 12-month retrospective fall incident data was collected. Information about the causes of falls was obtained from ALF staff using a standardized fall-incident assessment that was also used to collect the 12-month prospective fall data. Medications, ADLs, residents' history of falls, and Fractal D were entered as predictors in a multinomial logistic regression analysis, with falls as the outcome measure. The study team hypothesized that SGB would vary significantly with the MTS Fractal D measures, allowing Fractal D to be used as a proxy for SGB assessments while yielding improved fall prediction.

Specific Aims:

- Evaluate the relationship between conventional fall-risk assessment measures using performance on SGB tests and Fractal D movement tortuosity measures obtained through the MTS. **(Achieved)**
- Evaluate tortuosity changes preceding a fall. **(Achieved)**

- Gather requirements for a software module to perform online fall-risk assessment in community-based settings. **(Achieved)**

2012 Activities: The research team developed and published a manuscript in September in the *Journal of the American Medical Directors Association*, titled “[Path tortuosity in everyday ambulation of elderly persons’ increases predictability of fall risk beyond that provided by fall history, medication use, and standardized gait and balance assessments.](#)” This paper represents the first in a series of monographs being prepared by the team comparing Fractal D with known predictors of falling in older persons, such as having had a fall in the previous year, presence of psychoactive medications, and SGB assessments.

The first-phase medication analysis to evaluate the impact of psychoactive medications on fall risk in the subjects was completed. A manuscript describing the results of this analysis, in combination with the SGB analysis and the Fractal D tracking data, was developed and submitted to a peer-reviewed journal. Work proceeded on secondary analyses of this data. A 1-year no-cost extension was used to collect and analyze additional data. As last reported in the AHRQ Research Reporting System, project progress was on track and budget spending was on target. The project ended in September 2012.

A patent that resulted from the work was awarded and the technology has been licensed to a company. The team will market the product pending release of the research papers. Dr. Kearns was appointed to the implementation team for the Veterans Affairs (VA) Department Real-Time Location System Project, the intent of which is to place tracking technology in more than 150 VA-operated hospitals. He will also provide consultation concerning the development of a data repository that will be established to make these data available to researchers nationwide. Finally, the research team continues its work with the VA Smart Home Project to reduce the risk of falls among veterans receiving inpatient treatment for traumatic brain injury.

Impact and Findings: The major finding was that Fractal D is an independent predictor of future falls. Fractal D in combination with a history of one or more falls in the prior year is a strong fall predictor. The addition of a continuous dynamic assessment of changes in everyday movement patterns obtained automatically and unobtrusively up to the time of a fall significantly improves fall-risk estimation accuracy beyond that provided by other known predictors. In congregate living settings such as nursing homes and ALFs, the costs of the location-aware technology are kept relatively low by economies of scale since the infrastructure need not be pervasive, individual tag costs are low, and more than 100 residents can be monitored and assessed simultaneously.

While there was a significant difference in Fractal D for those who fell versus those who did not, the results did not indicate when group differences emerged. Auxiliary analyses indicated that those who fell did not differ significantly from those who did not at the time of the first week of the study, but were significantly different at the time of the fall. This change was not readily predictable from trends in the data nor was it linked to the duration until the fall. For those who fell, the correlation between Fractal D in the 7 days immediately preceding the index event with Fractal D in the week prior was 0.97, but was only 0.67 with participants’ measures during the first week of the study. The results are consistent with the hypothesis that Fractal D delivered by the online monitoring system is more predictive of falls in the near future than in the more distant past.

Target Population: Elderly*

Strategic Goal: Develop and disseminate health IT evidence and evidence-based tools to improve health care decisionmaking through the use of integrated data and knowledge management.

Business Goal: Knowledge Creation

** This target population is one of AHRQ's priority populations.*