

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 is developing and evaluating 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 aims 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 anticipate 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 from two ALF facilities. Baseline standardized gait and balance (SGB) assessments were completed. The velocity, distance and duration, and changes in direction during movements of 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 the time of enrollment, along with 12-month retrospective fall incident data. Information about the causes of falls was obtained from ALF staff using a standardized fall incident assessment also used to collect the 12-month prospective fall data. Medications, ADLs, and 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)**

2011 Activities: All medication data and fall history information for the baseline period and the monitoring interval was entered into the project database. Additionally, the research team continued medication coding and analysis. An abstract describing the results of the multinomial logistic regressions comparing traditional fall risk factors (prior fall and presence of psychoactive medications), against MTS Fractal D measures was submitted for presentation at the International Society for Gerontechnology's 2012 annual meeting to be held in Boston, November 14-18.

Results from the 53 subjects indicate that Fractal D is linked to future fall activity in ALF residents and that its contribution is quantifiable. Analyses of SGB measures and future fall risk showed that stride time coefficient of variation (COV) was a significant predictor of future falls for 35 of 53 subjects who could generate data. Fractal D was correlated with number of steps and time required to complete the *180 Degree Turn Test* and negatively correlated with the number of degrees rotated and sway area. Fractal D correlated positively with the time required to complete the *Get up and Go Test* and positively with *Walking Test* Dual Task stride-to-stride velocity COV.

As last self-reported in the AHRQ Research Reporting System, project progress and activities are on track and the project budget spending is on target.

Preliminary Impact and Findings: The logistic regression analysis performed on the 53 subjects revealed that the odds of falling increased by 4.06 times for every 0.1 increment in Fractal D levels the week before the event, and increased 3.45 times if a fall had occurred in the year prior to the study. The number of psychoactive medications approached but did not reach significance as a contributor to falls; neither was the mean path length a significant predictor of future falls, although there was a strong trend for longer paths and an absence of psychoactive medications to be associated with reduced fall risk. The concordance rate for the overall model was 82 percent.

SGB measures were available for too few subjects, (37 of 53) to conduct a multinomial logistic regression including the other measures listed above, largely due to the frailty of the subjects; many simply could not perform the stride test or other tests. Stride time COV was compared with the 7-day Fractal D mean, presence of more than one psychoactive medication, and the mean distance traveled in the 7 days before the event as predictors in a multinomial logistic regression. The results of the logistic regression on the reduced set of 34 subjects demonstrated that the COV was the best predictor of future falls. Fall probability increased 1.48 times for every .01 increase in the COV. No other variable was significantly related to fall risk, although Fractal D approached and may have reached statistical significance had more subjects been able to perform the stride time test. The concordance for the final model with 34 subjects was 87 percent. The logistic regression analysis was repeated on the same subjects dropping COV, and Fractal D was found to be the only significant predictor. A 0.1 increase in Fractal D was associated with a 4.17 times increase in fall likelihood. Neither the presence of more than one psychiatric medication nor the mean travel distance in the 7 days before the event was a significant predictor; the concordance rate for the model was 75.8 percent.

The study results indicate that a telesurveillance technology capable of extracting spatial variability information from free-moving elderly in assisted living facilities can provide useful information predictive

of future falls in individuals who may be too frail to engage in standardized gait and balance testing.

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.*