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A Data-Driven Analytical Model for Predicting Functional Loss and Recovery Among Older Adults

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Abstract

The number of nursing home residents who need help with their functional health, i.e., ability to perform the Activities of Daily Living, ADLs, is constantly increasing. Clinicians, patients, and their caregivers would benefit from information on likely next ADL events (both progression and recovery). While much of the focus in long-term care and the nursing home is on preservation and restoration of these activities, very little information is available to guide patients, providers, families, and policymakers regarding expectations for the sequence, likelihood, and timing of functional loss and recovery.

Predictive modeling, particularly Machine Learning, and availability of large data enables clinicians and patients to better understand what is likely to occur next. These forecasts can also set priorities for clinical interventions. Predictive modeling could also be used for planning purposes as it provides quantitative information on the timing and severity of the next disability event. Caregivers would like to know how long they need to provide care. Families would like to understand the likely quality of life of their loved one.

The objective of this study is to provide a data-driven analytical model, based on Machine Learning techniques, for predicting functional status change for residents in long term care facilities. Particularly, we predict:

1. the sequence in which ADLs were lost and recovered using large longitudinal data,
2. the days between ADL loss and recovery from these losses,
3. the likelihood of loss and improvement.

This information can help in planning for end-of-life disabilities. It can also be used to set “pay for improvement” incentives for providing long term care to older adults.

The sequence of functional loss and recovery among long term care residents is accurately predictable. This study provides benchmarks for the sequence, likelihood, transitions, and timing between various combinations of ADL deficits. While the majority of patients were able to recover from ADL deficits, the mean recovery time from a single ADL deficit suggests that recovery occurs over a long period and care planning needs predicting such timelines. This information can also be used to pay more for long term care facilities that perform better than average. In these payment systems, the percentage of patients that improved their condition is compared to the average percentage and additional payments are provided for the facilities that report better than average improvement rates.

Keywords

Healthcare Analytics, Aging , Planned Care, Functional Disabilities Among Older Adults

Biography

Mahsa Madani Hosseini is a lecturer in the Ted Rogers School of Management, Ryerson University, Toronto, Canada. She received her Ph.D. in Civil and Environmental Engineering with minor in Statistics from Concordia University. She also holds Project Management for Technical Professional Certificate at Ryerson University. In her research, she is interested in applying data analytics and statistical methods to focus on the intersection of health and environment.

Manaf Zargoush is an assistant professor of Health Policy & Management at the DeGroote School of Business, McMaster University. His main areas of research expertise and interests are using Data Science (machine learning, artificial intelligence, statistical modeling) for descriptive and predictive analytics and optimization (stochastic dynamic optimization, Markov and Semi-Markov Decision Processes, Partially Observable Markov Decision Processes) for prescriptive analytics of healthcare operations and information management, medical decision making, and Big Data. His current main projects are chronic disease (particularly hypertension) management under both noise-free and noisy measurements as well as trajectory/sequence/progression analytics of functional disabilities (and other chronic diseases) among older adults.

Farrokh Alemi is a professor of Health Policy and Administration at George Mason University. Dr Alemi was trained as an operations researcher and industrial engineer and has worked in both academia and health industry. His research focuses on causal analysis of massive data available in electronic health records. His publications have contributed to predictive medicine, precision medicine, comparative effectiveness of medications, sentiment analysis, natural language processing, risk adjusted analysis of cost effectiveness, causal networked models, identifying trajectories of diseases, and predicting prognosis of patients with multiple morbidities. Dr. Alemi is the author of the widely used Multi-Morbidity index. He has worked with diverse groups of patients including children, nursing home residents and patients with diabetes, major depression, heart failure, anemia, hypertension, trauma, drug abuse, and other diseases. He is the author of a book on decision analysis and another on policy systems and a third on application of process improvement to personal health.