Improving Care for Older Adults: A Model to Segment the Senior Population

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Abstract

Context: Risk stratification and tailored interventions are key population-level care management strategies among older adults, whose needs range from screening and prevention to end-of-life care.

Objective: To validate the Senior Segmentation Algorithm, a tool using administrative and clinical data from the electronic health record to identify each member aged 65 years and older as belonging to 1 of 4 Care Groups with similar needs: those without chronic conditions, with one or more chronic conditions, with advanced illness or end-organ failure, or with extreme frailty or nearing the end of life.

Design: Multiple validation methods.

Main Outcome Measures: Concordance with physician judgment, stability of segmentation over time, convergence with mortality, hospitalization, and readmission rates, and costs of care.

Results: Concordance of the algorithm with physician-assessed segmentation of 1615 Medicare recipients was 85%. After 1 year, approximately 85% of 86,140 surviving seniors remained in the same care group; 3.9% moved to a lower need group; and 11% moved to a higher need group. Six-month and 12-month mortality rates varied substantially across care groups. The algorithm performed similarly to the likelihood of hospitalization score in predicting hospitalization and readmissions.

Conclusions: The Senior Segmentation Algorithm accurately identifies older adults in care groups with similar needs, trajectories, and utilization patterns. It is being implemented in all Kaiser Permanente Regions, with the goal of determining key elements of care for members in each group. In addition, future efforts will aim to slow progression to higher need care groups and to identify necessary improvements in delivery system design.

Introduction

Tailored interventions are disease management strategies widely applied to patients who share chronic conditions, such as diabetes or congestive heart failure. Stratification of older adults into distinct risk categories is also relatively common. Clinical guidelines recommend incorporating life expectancy into decision making, leading to the development of general prognostic mortality indexes.[1] Other indexes assess the risk of readmission or death after hospital discharge in community-dwelling seniors, risk of functional decline among those with an Emergency Department visit, risk of functional dependence, and likelihood of hospitalization within six months.[2-8] Hierarchical condition categories risk-adjust Medicare and Medicaid payments on the basis of diagnostic categories.[9]

However, beyond disease management and risk stratification, broad segmentation of a population can better identify and address the distinct health care profiles and priorities of different groups comprising it.[10] The care needs of seniors vary from screening and prevention to management of complex conditions such as frailty, advanced illness, and the end of life. Consequently, a senior segmentation model was developed at Kaiser Permanente (KP) in which seniors fit best into one of four population care groups (Table 1). Care Group 1 consists of robust seniors without chronic conditions. Care Group 2 consists of seniors with one or more chronic conditions, such as diabetes, heart disease, and depression. Care Group 3 consists of seniors with advanced illness and end-organ failure, such as heart failure or chronic obstructive pulmonary disease. Care Group 4 includes seniors with advanced frailty or at the end of life. Although individuals may and do move between care groups over time, interventions and programs should be tailored and designed to meet the distinct needs of patients within care groups.

Operationalizing the senior segmentation model requires accurately identifying the care group within which each older adult best fits. This report describes the development of an algorithm for doing so and its validation by multiple methods.

Methods

Algorithm Development

The Senior Segmentation Algorithm (SSA) was developed using readily available data. We began with relatively simple rules based on risk scores and clinical criteria. Risk scores included the prospective risk score (DxCG Intelligence, Verisk Health Inc, Waltham, MA) and likelihood of hospitalization scores (Verisk Health Inc, Waltham, MA). Clinical indicators were based on hierarchical condition categories and chronic disease registries. Table 1 presents the risk score and clinical indicator profile for each care group.

Multiple data sources for the indicators in Table 1 are required. The DxCG scores require a DxCG data mart (Verisk Health Inc, Waltham, MA). Sources vary for chronic conditions' diagnoses and utilization data; for example, they may include point-of-care panel management tools and enterprise data warehouses.[11,12] Other clinical data can be found in the electronic health record (EHR)—KP HealthConnect—and include encounter diagnoses, the use of home oxygen and home hospital beds, surgeries and procedures, severe organ failure, and hospice or palliative care

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Table 1. Care groups in the senior population				
Care group	Health status	Risk scores	Clinical indicators	Potential care optimization
1	Robust with no chronic conditions	Low LOH and prospective DxCG[a] score	Exclusion criteria: chronic conditions, obesity, HIV/AIDS, depression, major mental health issues, substance abuse, skilled nursing facility residence, TIA, dementia or Alzheimer disease, stroke, and most lifelong diseases	Disease prevention, screening, and health promotion services
2	One or more chronic conditions	Moderate LOH and prospective DxCG[a] score	Exclusion criteria: dementia or Alzheimer disease of > 5 years' duration, severe organ failure (eg, organ transplant), spinal cord disorders/injuries, severe COPD, stroke, home oxygen therapy, major surgeries or procedures, selected cancers, etc	Disease management
3	Advanced illness and/or end-organ failure	Members not identified by criteria for other groups		Complex case management, advanced illness coordinated care, transitional care, guided care, and geriatric consultation
4	Extreme frailty or near the end of life	High LOH and prospective DxCG[a] score	Inclusion criteria: end-stage liver disease, liver transplant complications, hepatic coma, metastatic cancer and acute leukemia, abnormal weight loss for those aged > 85 years, current hospice or palliative care, home hospital bed, home oxygen therapy, combinations of dementia or Alzheimer disease and/or frailty, severe dementia documented in physician notes, etc	Home-based care, social work outreach, guided care, palliative care, and hospice care

[a] DxCG Intelligence, Verisk Health Inc, Waltham, MA.
COPD = chronic obstructive pulmonary disease; HIV/AIDS = human immunodeficiency virus/acquired immune deficiency syndrome; LOH = likelihood of hospitalization; TIA = transient ischemic attack.

orders. In addition, risk scores and indicators have been tailored to specifications in individual KP Regions, and regional implementation can add data specifically available and valuable to that Region.

The prototype SSA was improved on the basis of feedback from primary care physicians (PCPs). Patients in PCP panels were categorized into care groups for PCPs to review and provide feedback. Rules were then added, deleted, and tailored to reproduce as closely as possible PCP clinical judgments about appropriate care groups. For instance, long-term wheelchair use was deleted as a decision rule when PCPs identified that it did not correlate well with functional and/or ambulatory status. We retained rules that improved sensitivity and specificity.

Analysis

We assessed performance and the validity of the SSA in several ways. We examined the distribution of members across care groups and its stability over time. To assess the stability of population segmentation over time, we assessed the proportion of seniors who remained in their algorithm-assigned care group at one year and the proportion who moved to either a higher- or lower-need care group. Although the algorithm is intended to tailor care and not function as a predictive modeling tool, we hypothesized that utilization, mortality, and costs of care would all increase from care group to care group. Consequently, we assessed care group-specific mortality and hospital discharge rates and, among seniors with a hospital discharge, readmission rates. To assess care group-specific costs of care, we used monthly claims data to calculate an average cost per member per month in each care group. Finally, to examine concordance of the algorithm-assigned care group for individual seniors with physician clinical judgment, we asked physicians to review results from the algorithm and to make a clinical assessment as to whether classifications for individual patients in their panels were correct. We assessed concordance between physician judgment and the SSA using the κ coefficient. For comparison, we also assessed concordance of SSA-assigned care groups and segmentation on the sole basis of likelihood of hospitalization.

Results

Distribution of Seniors by Care Group and Stability of Care Groups over Time

Among 91,113 KP Northwest (KPNW) and KP Hawaii members aged 65 years and older, 13.5% were in Care Group 1; 62.3% in Care Group 2; 15.7% in Care Group 3; and 8.5% in Care Group 4. At 1 year, the majority remained in their initial care group. Most seniors whose care group changed at 1 year had moved to a higher need care group (Table 2). Migration to a lower need care group happened infrequently and typically resulted from lower utilization (which is incorporated into risk scores used in the SSA).

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Utilization, Mortality, and Costs

Among 61,189 KPNW members older than age 65 years as of January 1, 2010, we examined hospital discharges during the quarter following segmentation. The percentage of seniors with a hospital discharge doubled between each care group (Table 3). Among segmented KPNW seniors with hospital discharges, we examined 30-day, all-cause readmissions during the quarter following segmentation. The percentage of seniors with a readmission also increased across care groups.

Using the same data set, we examined mortality. At 6 and 12 months, 0.4% and 0.6% of members in Care Group 1 had died, compared with 15.2% and 28% of those in Care Groups 3 and 4 (Table 3). At 24 months, 50% of members in Care Group 4 had died.

Annualized costs of care increased approximately twofold between each care group and the next higher need one (Table 3).

Concordance with Physician Judgment

Six PCPs in 2 Regions assigned the members of their panels older than age 65 years to a care group; 1615 members were 65 or older and assigned by a physician to a care group. Physicians were aware of the SSA-assigned care group, and the physician-assigned group was identical to that of the SSA in 85% (1369) of senior panel members (Table 4). With few exceptions, the physician-assigned and SSA-assigned care group differed by only 1 level. Kappa coefficients calculated for each Region were 0.74 and 0.75, indicating substantial agreement between physician- and SSA-assigned care groups. In contrast, regional κ coefficients for SSA-assigned care group and likelihood of hospitalization were only 0.36 and 0.19, indicating slight to fair agreement.

Discussion

Senior segmentation is a health care system approach to population-based care for older adults. Care group stability over time, hospitalization, readmission, mortality, and cost data and concordance with physician clinical judgment support its further development. In contrast, the likelihood of hospitalization concordance with physician clinical judgment about assigned care group was less robust. The utility of SSA in practice will be ascertained when it is used to assess detailed patient needs and identify appropriate interventions.

Much individual variability remains in care groups. Nevertheless, the goal of senior segmentation is to ensure that the distinct needs of older adults in each care group are met. For example, in the absence of illness, the health care needs of individuals in Care Group 1 revolve around disease prevention, screening, and health promotion services. Individuals in Care Group 2 need more emphasis on disease management services and self-management. Among those in Care Group 3, care needs are more complex and require approaches above and beyond disease management. In Care Groups 3 and 4, aggressive efforts to reach target goals for chronic diseases are potentially counterproductive. In addition, more focus is needed on determining optimal nontraditional care design approaches for these care groups.

A strength of our work is that it is, to the best of our knowledge, the first report of a population-level approach to tailoring care to the varying health needs of older adults. Our ability to apply the SSA to more than 90,000 members reflects the efficiency of using administrative and clinical data to segment the large population of adults aged 65 years and older.

Several limitations deserve mention. PCPs were aware of the SSA results when assigning their patients to a care group; this may have affected the concordance we observed. Further study should include blinded validation of concordance. In this preliminary report, we are unable to comment on the impact of segmentation on indicators of care processes and outcomes, such as Healthcare Effectiveness Data and Information Set (HEDIS) measures, utilization patterns, and health status over time. Given that our goal is to optimize care for each group in the senior population, efficiency and member satisfaction are also pivotal outcomes that will need to be measured.

Another limitation pertains to functional status, which is a well-established predictor of health care utilization, outcomes, and quality of life in older adults. We were unable to incorporate direct measures of functional status into care group categorizations because of the lack of consistently accurate and available data in the EHR and logistically simple data collection methods. Instead, proxy measures for functional status, such as the presence of a hospital bed in the home, proved useful.

Last, the SSA was developed and validated in an integrated health care delivery system with a comprehensive EHR. The availability of the data elements in the algorithm determines its generalizability to other settings.

The senior segmentation algorithm is likely to evolve over time. Enhancements under consideration include incorporating member-reported health data related to general health status, frailty, health behaviors, and history of age-related risks (eg, falls, urinary incontinence, poor nutrition, and pain). Similarly, measures of the progression of primary disease would provide useful information, as would clinical trends related to specific diagnoses. Another type of clinical information useful for population segmentation relates to cancer diagnoses and includes staging, intent of treatment, and progression. Revisions of the algorithm will require additional validation.

Table 2. Surviving seniors in each initial care group who remained in that group or moved to another group at one year[a]

Care group at one year	Seniors in each initial care group, number (%)			
	1 (n = 11,751)	2 (n = 55,241)	3 (n = 13,375)	4 (n = 5773)
1	**8350 (71.1)**	1438 (2.6)	39 (0.3)	6 (0.1)
2	3140 (26.7)	**49,229 (89.1)**	1162 (8.7)	278 (4.8)
3	186 (1.6)	3499 (6.3)	**10,803 (80.8)**	686 (11.9)
4	75 (0.6)	1075 (1.9)	1371 (10.3)	**4803 (83.2)**

[a] Values in bold indicate surviving seniors who remained in their initial care group.

Table 3. Utilization and mortality by care group

Care group	1	2	3	4
Hospital discharges among seniors, %[a]	1	2	6	12
Thirty-day, all-cause readmissions among seniors with hospitalizations, %[a]	7	8	10	17
Annualized total costs of care, % of costs in Care Group 1	NA	220	440	840
Mortality,%				
6 months	0.4	0.5	2.6	15.2
12 months	0.6	1.2	5.5	28.0

[a] During the quarter after segmentation.
NA = not applicable.

Table 4. Concordance between physician judgment and segmentation by algorithm for 1615 seniors[a]

Algorithm-assigned segment	Physician-assigned segment				Total
	1	2	3	4	
1	**237**	23	0	1	261
2	9	**831**	60	4	904
3	6	84	**209**	14	313
4	0	7	38	**92**	137
Total	252	945	307	111	**1615**

[a] Values in bold indicate concordance.

Other methods might provide a more complete picture of older adults. Patients' self-reports yield important dimensions of information that are not usually available in the EHR. However, self-report is not currently uniformly available; it is also logistically intensive, requires interval reporting, and may be inaccurate at critical points in the patient journey. Clinician-based reports are also logistically intensive and prone to inconsistency.

Segmentation of the senior population provides a foundation for individualized assessment and patient-centered care. It is a tool intended to ensure that the individualized needs of all patients in each care group are met by informing clinical decision making. For instance, patients in Care Groups 3 and 4 may benefit from assessment of complex social and caregiver needs. Conversely, members of these care groups may be less likely to benefit from traditional disease prevention and management strategies, such as rigorous diabetes control.[13] In the Hawaii Region, care group status is now documented in the EHR, which is used across all settings. Patients in Care Group 4 who are hospitalized are evaluated for complex care needs. Clinicians use segmentation to manage population health, identify patients who are eligible for complex care management, prioritize patients with higher levels of need, and start conversations about needed services, such as mental health and caregiver support. In addition, care groups can be used to predict and plan for more resource-intensive care needs.

Senior segmentation is being implemented across KP. Risk scores and indicators can be tailored to specifications in individual KP Regions, and regional implementation can add data from clinical encounters, such as the problem list and encounter diagnostic codes. The experiences and comparative data of multiple Regions will contribute invaluable knowledge about care processes and outcomes across care groups, furthering our goal of optimizing health care for KP's one million older adult members.

Conclusion

Senior segmentation is a promising new method for identifying four Care Groups defined by member needs. The care for members within each group can be focused to address their varying health and utilization needs. Our assessment indicates that senior segmentation can form the foundation for population-level health delivery design. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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References

1. Yourman LC, Lee SJ, Schonberg MA, Widera EW, Smith AK. Prognostic indices for older adults: a systematic review. JAMA 2012 Jan 11;307(2):182-92. DOI: http://dx.doi.org/10.1001/jama.2011.1966.
2. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The functional independence measure: a new tool for rehabilitation. Adv Clin Rehabil 1987;1:6-18.
3. Clark DO, Stump TE, Tu W, Miller DK. A comparison and cross-validation of models to predict basic activity of daily living dependency in older adults. Med Care 2012 Jun;50(6):534-9. DOI: http://dx.doi.org/10.1097/MLR.0b013e318245a50c.
4. Joglekar A. DxCG likelihood of hospitalization model generates superior results [Internet]. South Jordan, UT: Verisk Health, Inc; 2007 Dec 14 [cited 2013 Mar 13]. Available from: www.ehcca.com/presentations/predmodel1/joglekar_2.pdf.
5. McCusker J, Bellavance F, Cardin S, Trépanier S, Verdon J, Ardman O. Detection of older people at increased risk of adverse health outcomes after an emergency visit: the ISAR screening tool. J Am Geriatr Soc 1999 Oct;47(10):1229-37.
6. van Walraven C, Dhalla IA, Bell C, et al. Derivation and validation of an index to predict early death or unplanned readmission after discharge from hospital to the community. CMAJ 2010 Apr 6;182(6):551-7. DOI: http://dx.doi.org/10.1503/cmaj.091117.
7. Suijker JJ, Buurman BM, ter Riet G, et al. Comprehensive geriatric assessment, multifactorial interventions and nurse-led care coordination to prevent functional decline in community-dwelling older persons: protocol of a cluster randomized trial. BMC Health Serv Res 2012 Apr 1;12:85. DOI: http://dx.doi.org/10.1186/1472-6963-12-85.
8. Pohl PS, Billinger SA, Lentz A, Gajewski B. The role of patient demographics and clinical presentation in predicting discharge placement after inpatient stroke rehabilitation: analysis of a large, US data base. Disabil Rehabil 2013 Jun;35(12):990-4. DOI: http://dx.doi.org/10.3109/09638288.2012.717587.
9. Pope GC, Kautter J, Ingber MJ, Freeman S, Sekar R, Newhart C. Evaluation of the CMS-HCC risk adjustment model. Research Triangle Park, NC: RTI International; 2011 Mar.
10. Lynn J, Straube BM, Bell KM, Jencks SF, Kambic RT. Using population segmentation to provide better health care for all: the "Bridges to Health" model. Milbank Q 2007 Jun;85(2):185-212. DOI: http://dx.doi.org/10.1111/j.1468-0009.2007.00483.x.
11. Feldstein AC, Perrin NA, Unitan R, et al. Effect of a patient panel-support tool on care delivery. Am J Manag Care 2010 Oct 1;16(10):e256-66.
12. Zhou YY, Unitan R, Wang JJ, et al. Improving population care with an integrated electronic panel support tool. Popul Health Manag 2011 Feb;14(1):3-9. DOI: http://dx.doi.org/10.1089/pop.2010.0001.
13. Kirkman MS, Briscoe VJ, Clark N, et al; Consensus Development Conference on Diabetes and Older Adults. Diabetes in older adults: a consensus report. J Am Geriatr Soc 2012 Dec;60(12):2342-56. DOI: http://dx.doi.org/10.1111/jgs.12035.

The Right of Dignity

A proud and resourceful nation can no longer ask its older people to live in constant fear of a serious illness for which adequate funds are not available. We owe them the right of dignity in sickness as well as in health.

— John F Kennedy, 1917-1963, 35th President of the United States