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More On: "Optimizing Suboptimal Classification Trees: S-PLUS® Propensity Score Model for Adjusted Comparison of Hospitalized *vs*. Ambulatory Patients with Community-Acquired Pneumonia"

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A recent article optimized ESS of a suboptimal classification tree model that discriminated hospitalized *vs*. ambulatory patients with community acquired pneumonia (CAP). This note suggests possible alternatives for two original attributes as a means of increasing model accuracy: patient disease-specific knowledge *vs*. "college education", and patient-specific functional status and social support *vs*. "living arrangement".

One attribute employed in the original[1] S-PLUS tree model is the minimum-granularity ordinal variable *College Graduate* having two response options, *Yes* or *No*, respectively indicating more *vs*. less education. A subsequent study[2] pruned the tree model to explicitly maximize achieved ESS (predictive accuracy normed *vs*. chance[3]), and recommended that future research in this area should "…identify and measure specific aspect(s) of 'education' that serve patients and other decision-makers in assessing appropriate placement (inpatient *vs*. outpatient) for each individual" (p. 45).

An example of an education-related construct considered in this context is the ability of patients to understand their particular illness and associated medical care. Screening tools were developed which enable physicians to rapidly identify patients having limited literacy so as to tailor instructions to their reading and understanding abilities.[4,5] It was discovered that 33% of Americans have basic or lower health literacy, and 27% of those on Medicare and 30% on Medicaid have less than basic health literacy.[6] Empirical findings report that health literacy is an important predictor of health status, is associated with decreased ability to take medications properly, more emergency department visits and hospitalizations, and higher health care costs.[7-9] However research also questions the ability of existing measures to adequately assess the three primary content areas of health literacy (comprehension of printed health materials, numeracy, information seeking/navigation), the extent to which available patient medical information is consistent with actual literacy requirements,

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exclusion biases involving non-English speakers and patients with significant sight or speech disabilities (thus underestimating the percentage of patients having low or marginal English health literacy), and the comparative importance of health literacy as it is currently assessed *vs*. the role of social support to predict preventability of patient hospitalization.[10-12]

A second attribute used in the original tree model is the minimum-granularity ordinal variable *Living Arrangement* comprising a 2x2 factorial design: the orthogonal binary (*No*, *Yes*) main effects are "Live with Others" and "In a Private Residence".[1] The left branch from this attribute is the interaction of the main effects (the terminal endpoint misclassifies 127 inpatients), and the right branch "Other" is thus both main effects.[2] It was recommended that future research in this domain should "…identify and measure specific aspect(s) of 'lives with others' and/or of 'in a private residence' that accurately predict inpatient *vs*. outpatient placement of individuals" (p. 45).

In contrast to research on the role of literacy in predicting patient hospitalization, and on availability of information appropriate for (poor and elderly) patients having low literacy, studies of patient "functional status"—operationalized in terms of the patient's ability to perform *basic* (dressing, eating) and intermediate (shopping, cleaning) activities of daily life, have been very productive. Early research concerning measurement[13,14], processing[15] and collection[16] of functional status information was conducted in the ODA Laboratory: in fact, the use of functional status information to discriminate geriatric *vs*. non-geriatric ambulatory patients was the focus of the first-ever published hierarchically-optimal classification tree model.[17,18] A cornucopia of literature addresses the importance of functional status in well-being of patients for a smorgasbord of diseases: for example, comprehensive heart failure management improved functional status and resulted in an 85% decrease in the hospital admission rate for discharged transplant candidates [19]; a patient's degree of functional impairment increases the risk of readmission post-discharge[20]; and the beneficial effect of exercise programs held in acute care hospitalization resulted in the emergence of hospital wards dedicated to early emphasis on rehabilitation of older adults admitted to acute care hospitals.[21]

Arguably the most ambitious project yet devised to evaluate/increase patient access to disease/situation-specific information, and to programs designed to increase patient functional status/social support, was recently initiated by the Robert Wood Johnson Foundation.[22] The premise of the "*Right Place, Right Time*" initiative is to better understand the challenges that vulnerable (e.g., uninsured, poor, non-English speakers) patients and caregivers experience in accessing health care information, and to offer recommendations regarding improving access to such information. Extensive patient interviews/ focus groups identified five recurring themes targeted by the initiative: *accessing health care information* (e.g., because vulnerable patients are unaware of available health care resources, search engines should provide mobile-friendly links to high-value resources about finding the "right doctor" as well as price and quality-of-care information); *increasing trust and respect between patients and providers* (e.g., received respect was often the primary concern regarding choice of health care provider); *health-care received from non-physicians* (e.g., patients who can't afford to see a doctor, take time off work, or have available childcare often rely on home remedies and pharmacist consultations—which which are free, available without appointment, and overcome the cost and time barriers to their medical care access); *family caregiver concerns* (e.g., caregivers expressed frustration regarding resources available to support them[23]); and issues for *non-English speakers* (e.g., immigrants often consider medical care appropriate for treatment of acute injuries and illnesses, and many having chronic disease don't seek/receive

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regular care or perceive this as a problem). This initiative does not include as a sixth facet the role of the patient in providing caregivers with accurate and timely information about their activities and symptoms, however mobile-friendly intelligent computer systems are now available for this purpose.[24]

References

[1]Stone RA, Obrosky DS, Singer DE, Kapoor WN, Fine MJ, and The Pneumonia Patient Outcomes Research Team (PORT) Investigators (1995). Propensity score adjustment for pretreatment differences between hospitalized and ambulatory patients with community-acquired Pneumonia. *Medical Care*, *4*, AS56-AS66.

[2]Yarnold PR (2019). Optimizing suboptimal classification trees: S-PLUS® propensity score model for adjusted comparison of hospitalized *vs*. ambulatory patients with community-acquired pneumonia. *Optimal Data Analysis*, *8*, 38-47.

[3]Yarnold PR (2017). What is optimal data analysis? *Optimal Data Analysis*, *6*, 26-42.

[4]Davis TC, Crouch MA, Long SW, Jackson RH, Bates P, George RB, Bairnsfather LE (1991). Rapid assessment of literacy levels of adult primary care patients. *Family Medicine*, *23*, 433–435.

[5]Arozullah AM, Yarnold PR, Bennett CL, Soltysik RC, Wolf MS, Ferreira MR, Lee SYD, Costello S, Shakir A, Denwood C, Bryant FB, Davis T (2007). Development and validation of a short-form Rapid Estimate of Adult Literacy in Medicine. *Medical Care*, *45*, 1026-1033.

[6]Kutner M, Greenberg E, Jin Y, Paulsen C (2006). *The health literacy of America's adults: Results from the 2003 National Assessment of Adult Literacy*. Retrieved from http://nces.ed.gov/pubs2006/2006483.pdf

[7]Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K (2011). Low health literacy and health outcomes: An updated systematic review. *Annals of Internal Medicine*, *155*, 97–107.

[8]Eichler K, Wieser S, Brügger U (2009). The costs of limited health literacy: A systematic review. *International Journal of Public Health*, *54*, 313–324.

[9]Haun JN, Patel NR, French DD, Campbell RR, Bradham DD, Lapcevic WA (2015). Association between health literacy and medical care costs in an integrated healthcare system: A regional population based study. *BMC Health Services Research*, *15*, 249.

[10]Dumenci L, Matsuyama RK, Kuhn L, Perera RA, Siminoff LA (2013). On the validity of the Rapid Estimate of Adult Literacy in Medicine (REALM) scale as a measure of health literacy. *Communication Methods and Measures*, *7*, 134-143.

[11]EI Omoye, Levinsohn E, Pan C, Howell BA, Streiter S, Rosenbaum JR (2017). Discrepancy between patient health literacy levels and readability of patient education materials from an electronic health record. *Health Literacy Research and Practice*, *1*, e203-e207

[12]Arozullah AM, Lee SD, Khan T, Kurup S, Ryan J, Bonner M, Soltysik RC, Yarnold PR (2006). The roles of low literacy and social support in predicting the preventability of hospital admission. *Journal of General Internal Medicine*, *21*, 140-145.

[13]Yarnold PR, Bryant FB, Repasy AB, Martin GJ (1991). The factor structure and cross-sectional distributional properties of the Beth Israel/UCLA Functional Status Questionnaire. *Journal of Behavioral Medicine*, *14*, 141-153.

2155-0182/10/$3.00

[14]Yarnold PR, Stille FC, Martin GJ (1995). Cross-sectional psychometric assessment of the Functional Status Questionnaire: Use with geriatric versus nongeriatric ambulatory medical patients. *International Journal of Psychiatry in Medicine*, *25*, 305-317.

[15]Yarnold PR, Stewart MJ, Stille FC, Martin GJ (1996). Assessing functional status of elderly adults via microcomputer. *Perceptual and Motor Skills*, *82*, 689-690.

[16]Yarnold PR, Feinglass J, Martin GJ, McCarthy WJ (1999). Comparing three pre-processing strategies for longitudinal data for individual patients: An example in functional outcomes research. *Evaluation and the Health Professions*, *22*, 254-277.

[17]Yarnold PR (1996). Discriminating geriatric and non-geriatric patients using functional status information: An example of classification tree analysis via UniODA. *Educational and Psychological Measurement*, *56*, 656-667.

[18]Yarnold PR, Bryant FB (2015). Obtaining a hierarchically optimal CTA model via UniODA software. *Optimal Data Analysis*, *4*, 36-53.

[19]Fonarow GC, Walden JA, Livingston NA, Steimle AE, Hamilton MA, Moriguchi J, Tillisch JH, Woo MA (1997). Impact of a comprehensive heart failure management program on hospital readmission and functional status of patients with advanced heart failure. *Journal of the American College of Cardiology*, *30*, 725-732.

[20]Burke LG, Jha AK (2015). Patients' functional status and hospital readmissions: Remembering what matters. *JAMA Internal Medicine*, *175*, 565-566.

[21]Hall WJ (2019). A novel exercise intervention and functional status in very elderly patients during acute hospitalization. *JAMA Internal Medicine*, *179*, 36-37.

[22]Knowledge is power: Improving health care information for the most vulnerable. https://www.healthaffairs.org/do/10.1377/hblog20160525.055033/full/

[23]Collinge W, Kahn J, Walton T, Kozak L, Bauer-Wu S, Fletcher K, Yarnold PR, Soltysik RC (2013). Touch, caring, and cancer: Randomized controlled trial of a multimedia caregiver education program. *Supportive Care in Cancer*, *21*, 1405-1414.

[24]Collinge W, Yarnold PR, Soltysik RC (2013). Fibromyalgia symptom reduction by online behavioral self-monitoring, longitudinal single subject analysis and automated delivery of individualized guidance. *North American Journal of Medical Sciences*, *5*, 546-553.

Author Notes

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