The Effect of Self-Reported and Performance-Based Functional Impairment on Future Hospital Costs of Community-Dwelling Older Persons

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Purpose: We determined the prognostic value of self-reported and performance-based measurement of function, including functional transitions and combining different measurement approaches, on utilization. Design and Methods: Our cohort study used the 6th, 7th, and 10th waves of three sites of the Established Populations for Epidemiologic Studies of the Elderly, linked to 1- and 4-year Medicare Part A hospital costs. We examined mean hospital expenditures based on (a) 1- and 4-year transitions in self-reported functional status; (b) 4-year transitions in performance-based functional status; (c) combined baseline self-reported and performance-based functional status; and (d) poorest self-reported and performance-based functional status during a 4-year period. Results: Even modest declines in self-reported or performance-based functional status were associated with increased expenditures. When baseline self-reported and performance-based assessments were combined, mean 1- and 4-year adjusted costs were higher with progressively worse performance-based scores, even among those who were independent in self-reported function. When the poorest 4-year self-reported and performance-based functions were examined, self-reported functioning was the most important determinant of hospital costs, but within each self-reported functional level, poorer performance-based function was associated with progressively higher costs. Implications: The costs associated with even modest functional decline are high. Combining self-reported and performance-based measurements can provide more precise estimates of future hospital costs.

Key Words: Health care costs, Disability, Medicare

Despite efforts to control health care costs of seniors, medical expenses have increased at a much faster rate among Medicare beneficiaries than in the nonelderly patient population (Wilensky, 2001). Moreover, the costs of caring for older persons are not distributed evenly across the elderly population. In fact, 10% of Medicare beneficiaries are estimated to account for 70% of annual medical expenditures for this program (Health Care Financing Administration [HCFA], 1995). Several other studies have confirmed that a small percentage of high utilizers are responsible for substantial portions of total health care expenditures (Berk & Monheit, 2001; Lubitz & Riley, 1993; Roos, Shapiro, & Tate, 1989). Accordingly, there has been considerable interest in identifying older persons who have high health care utilization, and a variety of approaches have been developed that incorporate sociodemographic characteristics, lifestyle factors, and health conditions (Boul et al., 1993; Howland, Stokes, Crane, & Belanger, 1987; Miller et al., 1998; Reuben, Keeler, Seeman, et al., 2002). Many of these approaches include functional status, which can be viewed as a summary measure of the overall impact of medical...
conditions, lifestyle, and age-related physiologic changes in the context of the older person's environment and social-support system.

Functional disability is common among older persons (Administration on Aging [AOA], 2001) and it can be easily measured by self-report or direct observation (performance based). Each method of measuring functional status has relative advantages and disadvantages (Guralnik et al., 1994), but both methods can predict adverse outcomes such as functional decline, mortality, and high health care utilization (Fried, Bradley, Williams, & Tinetti, 2001; Pacala, Boult, & Urdangarin, 2000; Penninx et al., 2000; Sutton & Aliberti, 1994; Weiner et al., 2000). In the prediction of high health care utilization, generally only baseline functional status has been used to predict costs. Although intuitively important, the costs of functional transition have not been well studied. Recently, Fried and colleagues (2001) demonstrated that the 16% of community-dwelling older persons in New Haven who experienced 2-year functional decline from independence in seven basic activities of daily living to difficulty or dependence in at least one of these accounted for approximately 24% of weighted hospital expenditures and 27% of all weighted expenditures.

Moreover, the predictive value of combining self-reported and performance-based functional measures is only beginning to be demonstrated. In a recent analysis of the Established Populations for Epidemiologic Studies of the Elderly (EPESE) database, combining these two approaches enabled researchers to better classify community-dwelling older persons with respect to risk of mortality than either method alone (Reuben, Keeler, Hayes et al., 2002). However, it is uncertain whether this combined approach is able to predict subsequent health care utilization better than either method alone.

In this study, we used EPESE and HCFA (now the Center for Medicare and Medicaid Services) data to determine 1- and 4-year Medicare Part A hospital costs of older persons associated with transitions in self-reported and performance-based functional impairments. We also examined the value of combining self-reported and performance-based measures at baseline and during functional transitions over 1 and 4 years in predicting subsequent Medicare Part A costs. By doing so, one can also estimate the potential cost savings of maintaining or restoring functional health.

Methods

The EPESE was conducted from 1981 to 1992. At baseline (in years 1981 and 1982) and in subsequent waves, EPESE collected a broad array of self-report information. In the sixth follow-up wave in 1988, an in-home interview was conducted in which self-report and basic physical examination (including performance-based measures) data were collected. Because the sixth follow-up wave was the only wave to include physical examinations, including Physical Performance Scale (PPS) assessment, we used this wave as the inception point for subsequent Medicare Part A hospital utilization.

We focused the analysis on variables that were collected at the 6th, 7th, and 10th follow-up. All three sites (Iowa, New Haven, and East Boston) used in these analyses have complete PPS and functional status (including disability) data available for the 6th follow-up wave. After the 6th follow-up, the EPESE sites were less consistent in the data collected. The Iowa and New Haven sites collected self-reported activity of daily living (ADL) and mobility items at the 7th follow-up, and Iowa also collected these variables at the 10th follow-up (Guralnik et al., 2000). Iowa also collected PPS data at the 10th follow-up.

Sample

The study utilized data from three sites of the EPESE study, a longitudinal study of older persons residing in three communities—East Boston, a blue-collar community composed of low- and middle-income working-class persons, most of whom were Italian American; Iowa and Washington Counties, two rural counties in East Central Iowa where agriculture is the major industry; and New Haven, where the largest employers are educational institutions, manufacturing, and service industries. The sampling frame for each site differed, and EPESE is not intended to generate population-based estimates. East Boston employed a total community census whereas Iowa used a private census of the area supplemented by lists of elderly persons compiled by the Area's Agency on Aging. New Haven conducted a stratified cluster sampling of three different types of residents: those dwelling in public housing, in private housing for the elderly, and elsewhere in the community. Participation rates ranged from 76% to 89% across sites and subgroups (Corno-Huntley et al., 1986).

At the initial baseline interview there were 10,294 participants aged 65 and older. At the time of the sixth follow-up (the baseline for the current study), 3,200 participants were known to have died, 113 were lost to follow-up, and 414 refused to be interviewed. Of the remaining 6,567 persons, 543 were determined to be in a nursing home at that time, 452 had their interview through a proxy, 383 were interviewed through telephone, and 51 could not be linked to HCFA data to obtain Part A Medicare costs. After these participants were excluded, 5,138 cases were available for analyses at baseline for the present analyses. Participants in the analytic data set were slightly younger (78.4 vs. 79.2 years) and better educated (14.4% vs. 13.6% having
high school or greater education) compared with the entire eligible sample; there were no gender differences.

Because of inconsistencies in EPESE data collection across sites, the sample sizes for changes in functional status are smaller. Information on disability status at 1 year (7th follow-up) was obtained on 1,924 persons in Iowa and 1,157 persons in New Haven; 123 and 66 participants had died at these sites, respectively, at 1 year. Information on disability status at 4 years (10th follow-up) was obtained on 1,603 persons in Iowa; an additional 435 persons had died during this follow-up.

**Measures**

We measured self-reported functional status by using selected ADLs (Katz, Downs, Cash, & Grotz, 1970) and mobility-related functional tasks (Rosow & Breslau, 1966). In this study, the ADLs included self-reports of bathing, transferring from bed to chair, dressing, eating, and using the toilet. We dichotomized these variables as being unable to do or requiring human help (dependent) versus able without help (independent). We defined mobility-related disability as in previous EPESE reports (Corti, Guralnik, Salive, & Sorkin, 1994), using two items from the Rosow-Breslau scale: inability to walk half a mile or to walk up and down stairs to the second floor without help. A person reporting the inability to perform either of these tasks was considered to be disabled.

In a manner similar to previous EPESE analyses, we established a hierarchical scale for self-reported functional status that included three levels: (a) independence in mobility and all ADLs (64.4%); (b) dependence in mobility and independence in all ADLs (26.6%); and (c) dependence in mobility and one or more ADLs (7.1%). Only 96 of the 5,138 participants (1.9%) could not be classified with this system (e.g., they were independent in mobility but impaired in ADL functioning) and were dropped from the analyses that included self-reported functional status.

We measured performance-based functional status by using the PPS. This measure consists of three tasks: (a) standing with the feet together in the side-by-side, semitandem, and tandem positions and attempting to hold these positions for 10 s; (b) walking 8 ft (244 cm), which is timed; and (c) rising from a chair and returning to the seated position five times, which is also timed. The battery has been validated in the EPESE cohort after being administered to more than 5,000 participants in their homes and can distinguish risk for mortality and nursing-home placement among older persons who are at the high end of the functioning spectrum (Guralnik et al., 1994). The instrument has also been predictive of subsequent 1- and 4-year disability in the EPESE population (Guralnik, Ferrucci, Simonsick, Salive, & Wallace, 1995). We scored the PPS as it has been used in previous studies in four categories (10–12, 7–9, 4–6, and 0–3), with 0 indicating worst and 12 indicating best performance (Guralnik et al., 1995, 2000). Because we did not have a priori hypotheses about the effects of different cut points on hospital costs, we did not explore alternative scoring systems.

We operationalized direct costs or charges according to Medicare Part A claims data for hospital expenditures and reported them as continuous mean data, limited (winsorized) to no more than $60,000 for 1-year costs and to $135,000 for 4-year costs (the top 0.8% of expenditures) to mitigate the effect of outliers; we rounded to the nearest $100. We used cost data rather than hospital days because cost data also include intensity of treatment per day.

**Analysis**

We first examined 1- and 4-year transitions in self-reported functional status by using the hierarchical scale and calculated the mean expenditures incurred by persons in each of these states of transition. Next, we examined 4-year transitions in PPS functional status and mean expenditures incurred by persons in each of these states of transition. We then combined baseline self-reported functional status with baseline PPS functional status to create a more precise method of categorization. In this approach, we utilized the three states of self-reported functional status and the four states of PPS function to create 12 unique categories. However, only 10 of these had enough cases (n ≥ 20) for analysis; the other 2 categories, ADL impairment and high or medium-high performance-based functional status, would be clinically improbable and, as expected, had too few cases for meaningful analysis. For each of these categories, we calculated 1- and 4-year hospital expenditures.

We then examined expenditures as a result of 4-year combined self-report and PPS functional status transitions. Because of the large number of possibilities of functional transitions (three self-reported categories and four performance-based categories with the capacity for different magnitudes of change), we examined patterns of utilization on the basis of baseline and 4-year functional self-reported and PPS status. On the basis of exploratory analyses suggesting that costs follow the nadir of functional status (i.e., costs appear to be more closely related to the poorest level of function regardless of whether it is at baseline or follow-up), we categorized participants according to the poorest level of self-reported and performance-based function. Among those who were ADL impaired (Level C) at any time during the 4-year follow-up, there was not enough distribution among PPS categories to conduct meaningful...
comparisons based on PPS status. Accordingly, those whose nadir of self-reported function was ADL impairment were aggregated.

For all analyses, we created multivariable models for all mean expenditures, adjusting for age, gender, race, marital status, and study site. In the models for Tables 1, 2, and 4, we used dummy variables for each of the cells in the tables. We used all such cells with enough entries to estimate (fully interacted). In the models for Table 3, we used indicators for each level of baseline self-reported and PPS status, and we tested for interactions between self-report and PPS function. After estimating the models, we used recycling (Graubard & Korn, 1999), a form of direct standardization, to interpret the effects of each functional category. The cell entries for each category represent average predicted costs for the entire sample, if we assume they were in that functional category but retained their other characteristics.

Because participants may not have survived a full year, we also calculated annualized, weighted 1-year expenditures to account for this shortened survival. We annualized data by determining monthly costs, which were annualized, weighted for the number of months survived, totaled, and divided by the total number of months that the participant was alive during that year. For example, consider 2 participants (A and B). Participant A spent $3,600 during the year, and Participant B spent $5,000 in the first month and died during that month. Participant B’s annualized expenses were $60,000 with a weight of 1/12. Thus, the weighted sum is $8,600 ($3,600 plus 1/12 of $60,000, or $5000), which is then divided by 13/12 years to give an annualized, weighted cost.

We used the STATA 7.0 exponential regression procedure to estimate adjusted predicted expenditures based on maximum-likelihood exponential models. Significance tests for sets of variables in these maximum-likelihood models were based on chi-squared (N) statistics where N is the number of added variables.

### Table 1. 1- and 4-Year Medicare Part A Mean Expenditures Based on Changes in 1- and 4-Year Self-Reported Functional Status

<table>
<thead>
<tr>
<th>Baseline Level</th>
<th>1 Year</th>
<th></th>
<th>4 Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>All Within Row</td>
</tr>
<tr>
<td>A</td>
<td>900</td>
<td>2,000</td>
<td>8,700a</td>
<td>12,000a</td>
</tr>
<tr>
<td>B</td>
<td>1,900</td>
<td>2,000</td>
<td>4,700</td>
<td>8,600</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>1,400</td>
<td>4,800</td>
<td>12,000</td>
</tr>
<tr>
<td>All within column</td>
<td>900</td>
<td>2,000</td>
<td>5,200</td>
<td>10,600</td>
</tr>
<tr>
<td></td>
<td>3,800</td>
<td>7,900</td>
<td>12,400b</td>
<td>14,200b</td>
</tr>
<tr>
<td></td>
<td>6,900c</td>
<td>8,100c</td>
<td>11,500</td>
<td>17,000</td>
</tr>
<tr>
<td></td>
<td>NA</td>
<td>NA</td>
<td>14,000d</td>
<td>10,600d</td>
</tr>
<tr>
<td></td>
<td>3,900</td>
<td>8,000</td>
<td>12,100</td>
<td>14,700</td>
</tr>
</tbody>
</table>

Notes: For 1 year, n = 3,046; for 4 years, n = 1,964. Expenditures are adjusted for age, gender, race, marital status, and site. 1-year costs were winsorized to a maximum of $60,000 and 4-year costs were winsorized to a maximum of $135,000; both were rounded to the nearest $100. All numbers in the table are given in dollars. NA = cells with a sample size < 20 are excluded; ADL = activity of daily living; A/W = annualized, weighted. Hierarchical functional status is as follows: Level A = independent in mobility and all ADLs; Level B = dependent in mobility and independent in all ADLs; Level C = dependent in mobility and 1 or more ADLs.

All differences between cells within rows are significant at the p < .05 level, except those pairs flagged with a superscript letter. All differences between row totals and column totals are significant at the p < .05 level.

### Table 2. 4-year Medicare Part A Mean Expenditures Based on 4-year Changes in the PPS Score

<table>
<thead>
<tr>
<th>Baseline Score</th>
<th>4-Year</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10–12</td>
<td>7–9</td>
</tr>
<tr>
<td>10–12</td>
<td>2,900</td>
<td>4,000</td>
</tr>
<tr>
<td>7–9</td>
<td>4,400</td>
<td>5,000</td>
</tr>
<tr>
<td>4–6</td>
<td>NA</td>
<td>5,600a,b</td>
</tr>
<tr>
<td>0–3</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>All within column</td>
<td>3,200</td>
<td>4,600</td>
</tr>
</tbody>
</table>

Notes: For the table, n = 1,704; expenditures are adjusted for age, gender, and marital status. Costs are winsorized to a maximum of $135,000 and rounded to the nearest $100. Except for the baseline score and 4-year score, all numbers in the table are given in dollars. NA = cells with a sample size < 20 are excluded; PPS = Physical Performance Scale.

All differences between column totals are significant at the p < .05 level. All differences between row totals that exceed $1,000 are significant at the p < .05 level, except the pair flagged with superscript a, b, or c.

Results

Sociodemographic characteristics of the entire sample were as follows: mean age, 78.4 years; percentage female, 65.1; percentage African American, 5.1; percentage with fewer than 9 years of education, 42.4; and percentage with more than high school education, 14.4.

In Table 1, we present hospital expenditures based on self-reported functional status. Participants who remained in the highest functioning group had the lowest health care expenditures. Including functional-status change increased the precision of cost estimates. For example, the mean for 1-year hospital...
Table 3. Mean 1- and 4-Year Medicare Part A Expenditures for Groups Based on Combined Baseline Self-Reported (A and B only) and Performance-Based Functional Status

<table>
<thead>
<tr>
<th>Functional Status</th>
<th>1-Year Costs (Baseline Performance Score)</th>
<th>4-Year Costs (Baseline Performance Score)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10–12</td>
<td>7–9</td>
</tr>
<tr>
<td>A</td>
<td>1,400</td>
<td>2,100</td>
</tr>
<tr>
<td>B</td>
<td>2,700</td>
<td>3,200</td>
</tr>
<tr>
<td>C</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>All within column</td>
<td>1,500</td>
<td>2,400</td>
</tr>
</tbody>
</table>

Notes: For both 1 and 4 years, n = 4,464. Expenditures are adjusted for age, gender, race, marital status, and site; 1-year costs were winsorized to a maximum of $60,000, and 4-year costs were winsorized to a maximum of $135,000; both were rounded to the nearest $100. Except for PPS scores, all numbers in the table are given in dollars. Hierarchical functional status is as follows: Level A = independent in mobility and all ADLs; Level B = dependent in mobility and independent in all ADLs; Level C = dependent in mobility and 1 or more ADLs. All numbers in the table are given in dollars. PPS = Physical Performance Scale; ADL = activity of daily living. For 1-year costs, all differences between cells that exceed $500 are significant at p < .05.

Table 4. 4-Year Hospital Costs Based on Poorest Self-Reported and Performance-Based Functional Status Over 4 Years

<table>
<thead>
<tr>
<th>Functional Status</th>
<th>4-Year Mean Expenditures (Poorest PPS Score)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10–12</td>
</tr>
<tr>
<td>A</td>
<td>1,900</td>
</tr>
<tr>
<td>B</td>
<td>—</td>
</tr>
<tr>
<td>C</td>
<td>—</td>
</tr>
<tr>
<td>Dead</td>
<td>14,900</td>
</tr>
</tbody>
</table>

Notes: Expenditures are adjusted for age, gender, and marital status (n = 1,827). The 4-year mean expenditures are winsorized to a maximum of $135,000 and rounded to the nearest $100. PPS cells with fewer than 20 participants have been omitted. The “Poorest” is the worst self-report or PPS score (baseline, 1 year, or 4 year). Hierarchical functional status is as follows: Level A = independent in mobility and all ADLs; Level B = dependent in mobility and independent in all ADLs; Level C = dependent in mobility and 1 or more ADLs. All numbers in the table are given in dollars. PPS = Physical Performance Scale; ADL = activity of daily living.

All differences between cells that exceed $1,200 are significant at p < .05 except those pairs flagged with a superscript.
greatly improve predictions, but the PPS categorization is somewhat more discriminating than the self-report classification. For 4-year costs, significance levels of the categories are similarly enormous, but the self-report categorization is somewhat more discriminating than the PPS categorization. For both 1- and 4-year costs, interactions between the two categorizations were negligible.

In Table 4, we present expenditures as a result of 4-year transitions based on the combined self-reported and PPS functional status, categorizing participants according to the poorest levels of self-reported and performance-based function. Those who never dipped below the top self-report and PPS categories had the lowest hospital expenditures. For those whose self-report and PPS scores were less than perfect, there was a progressive gradient of hospital costs such that the self-reported functional-status levels were hierarchical, and within each self-report functional level, PPS levels were also hierarchical. Within self-reported functional-status levels, all cells were significantly different from each other except the two middle PPS categories (7–9 and 4–6) in the highest self-report categories (Levels A and B).

Discussion

Previous research has primarily relied on baseline functional status as a predictor of future costs. In this study, we examined the effect of change in functional status on hospital costs, which is the major health care expenditure for older persons. In this longitudinal community-based cohort of elderly persons, we found that even modest declines in self-reported or performance-based functional status were associated with higher hospital costs over the subsequent 1 and 4 years. We were also able to demonstrate that, among persons who did not have ADL impairment, combining baseline self-reported and performance-based measures further refined the predictive precision of functional status on future hospital costs. These findings are consistent with a study demonstrating the predictive value of combining baseline self-reported and performance-based measures on mortality (Reuben, Keeler, Hayes et al., 2002).

However, when we examined transitions in combined self-reported and performance-based measures, preliminary analyses indicated that hospital costs were most closely associated with the poorest functional status during the observation period rather than functional decline per se. Using the nadir of self-reported and performance-based functional status over a 4-year period provides a gradient of health care costs. Within this gradient, self-reported functional status is the most important determinant of hospital costs, but poorer performance-based function within each self-reported functional level is associated with progressively higher costs. Although Fried and colleagues (2001) demonstrated that decline in function accounted for a greater percentage of hospital expenditures than either stable dependence or improvement in ADL function, that study did not consider mobility dependency or performance-based function. The argument that functional impairment, regardless of when it occurs during a defined time period, increases hospital costs makes intuitive sense. For example, an older person may be functioning poorly at the beginning of the follow-up period, be hospitalized with subsequent recovery of function, and may incur no further costs. Another older person may be functioning well until late in the follow-up period and then experience a functional decline either resulting in or caused by a hospitalization. In either case, the number of hospital days may be identical. In both the Fried study and ours, those who died incurred the highest hospital costs, confirming the high costs of terminal illness.

From a clinical perspective, the most important finding is the increased precision that can be obtained when self-reported and performance-based measures at baseline are combined in those who do not have ADL impairment. For 1-year costs, both PPS and self-report categories greatly improve predictions, but the PPS categorization is somewhat more discriminating than the self-report classification. For example, among those who had no mobility or ADL impairment, the 1-year hospital costs of persons who scored poorest on the performance-based measure were more than twice as high as those who scored in the top category. Moreover, large differences in 4-year expenditures could be demonstrated on the basis of a single self-reported and performance-based assessment at baseline. For 4-year costs, the self-report categorization is somewhat more discriminating than the PPS categorization. Such information may be quite valuable to a health plan in estimating its costs of individual members or in directing functionally impaired persons to interventions such as disease management, case management, comprehensive geriatrics assessment, or health-promotion programs.

From a planning or policy perspective, however, our findings on the impact of functional transition and the close linkage of costs to the nadir of functional impairment are probably most important. When estimating costs for a population, insurers must consider both baseline and future functional status and assume that the worst will be the best predictor of hospital costs. Thus, knowing the functional transition rate of the population is as important as knowing the baseline functional status. These findings also have implications for the development of interventions, both nonpharmacologic and pharmacologic, that may prevent diseases that contribute to decline, rehabilitate dysfunction that has occurred, and modify the environment to facilitate function. For example, maintaining someone who is independent in mobility and ADL function at the highest PPS category would be
expected to save $2,000 over 4 years compared with allowing that person to decline to the next best PPS category.

These findings must be interpreted in the context of the study’s limitations. First, the study sample was not a nationally representative population. Rather, it was confined to three communities and had little representation of ethnic minorities. In addition, the exclusion of nursing-home residents and the loss of sample size that occurred because some participants were missing functional status or outcome data limit the generalizability of the findings. Second, the sample size, particularly for change in PPS function, was relatively small for estimating costs, which vary widely. Third, the assessment of functional status measures was infrequent (baseline, 1, and 4 years for self-reported functional status and baseline and 4 years for performance-based measures). As a result, substantial change may have occurred in between measurements. However, such change would likely have resulted in misclassification that would have tended to obscure differences between groups. Fourth, these data were collected in the early 1990s, and temporal changes may have occurred, particularly in health care delivery. This study did not consider health care provider or organizational interventions that might improve functional status (Reuben, 2002).

In conclusion, this study indicates that even minor functional transitions have substantial cost implications. Combining self-reported and performance-based methods may improve precision in predicting subsequent hospital costs. When examining transitions in function by using both self-reported and performance-based measures in combination, we learned that the nadir of functional status over time may also provide information about costs during this time period. Although this observational study is not able to provide evidence that maintaining or restoring functional health would be cost saving, these findings indicate the potential for cost savings if effective interventions to prevent functional decline are developed. Accordingly, these new insights into the economic impact of functional status may be valuable to researchers seeking to develop interventions to prevent functional decline, health planners who must anticipate future costs of older persons, and clinicians who are attempting to prevent future hospitalizations in their older patients.

References


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