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The Volume-Outcome Relationship in Nursing Home Care:

An Examination of Functional Decline Among Long-term Care Residents

Yue Li, PhD[*], **Xueya Cai, PhD**[†], **Dana B. Mukamel, PhD**[*], **Laurent G. Glance, MD**[‡]

[*]Health Policy Research Institute, and Department of Medicine, University of California, Irvine, CA

[†]Division of Biostatistics, Indiana University School of Medicine, Indianapolis, IN

[‡]Department of Anesthesiology, University of Rochester School of Medicine and Dentistry, Rochester, NY

Abstract

Background: Extensive evidence has demonstrated a relationship between patient volume and improved clinical outcomes in hospital care. This study sought to determine whether a similar association exists between nursing home volume of long-term care residents and rates of decline in physical function.

Methods: We conducted retrospective analyses on the 2004 and 2005 Minimum Data Set files that contain 605,433 eligible long-term residents in 9336 nursing homes. The outcome was defined following the federal "Nursing Home Compare" measure that captures changes in 4 basic activities of daily living status between 2 consecutive quarters. Both the outcome measure and nursing home volume were defined on the basis of long-term care residents. We estimated random-effects logistic regression models to quantify the independent impact of volume on functional decline.

Results: As volume increased, nursing home's unadjusted rate of functional decline tended to be lower. After multivariate adjustment for baseline resident characteristics and the nesting of residents within facilities, the odds ratio of activities of daily living decline was 0.82 (95% confidence interval: 0.79–0.86, $P < 0.000$) for residents in high-volume nursing homes (>101 residents/facility), compared with residents in low-volume facilities (30–51 residents/facility).

Conclusions: High volume of long-term care residents in a nursing home is associated with overall less functional decline. Further studies are needed to test other important nursing home outcomes, and explore various institutional, staffing, and resource attributes that underlie this volume-outcome association for long-term care. Understanding how greater experience of high-volume facilities leads to better resident outcome may help guide quality improvement efforts in nursing homes.

Reprints: Yue Li, PhD, Health Policy Research Institute, University of California, Irvine, 111 Academy, Suite 220, Irvine, CA 92697. yli11@uci.edu.

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Keywords

volume-outcome association; long-term care; nursing home; activities of daily living; functional decline

Over the past 2 decades, much research on hospital care has explored the relationship between patient volumes and clinical outcomes.[1–4] Evidence suggests that hospitals and physicians with high patient volumes generally show better outcomes, such as lower mortality, for a range of surgical and medical conditions.[3–9] For example, a systematic review identified 27 procedures and clinical conditions for which volume is shown to predict improved outcome.[2] This consistently documented volume-outcome association has prompted widespread interest of health care purchasers and consumers in seeking ways to regionalize care to high-volume providers.[10,11]

In this study we sought to determine whether a parallel association exists between the volume of nursing home residents and outcome of nursing home care in the nation. Nursing home services are delivered to heterogeneous patient groups, such as postacute and long-term care residents with multiple and interrelated conditions, and are characterized by diverse goals of patient health assessment and disease management. Although a priori it is not clear whether the volume-outcome associations observed in acute care settings can be generalized to nursing homes, the issue is just as important because nursing facilities vary considerably both in the number of patients they care for and in various clinical outcomes that reflect multiple dimensions of care.[12–14]

One of the most important outcomes for long-term care residents is their functional status or ability to maintain basic self-care activities, because it is central to the welfare of the elderly and is a sensitive clinical indicator to monitor disease progression and response to therapy.[15] In addition, functional decline often predicts cognitive impairment or mortality,[16] and places residents at risks for common geriatric morbidities, such as pressure ulcers and urinary incontinence.[13] In contrast, prevention of functional decline among long-term care residents can be achieved through successful management of common disabling conditions, such as stroke, dementia, and prevention of falls.[15,17]

The quality of nursing home care has been a major focus of policymakers for many years. A recent effort in response to the public demand for information on quality is the “Nursing Home Compare” report cards published by the Centers for Medicare and Medicaid Services (CMS).[13,14] This public report contains a series of key outcome measures of nursing home care, including decline in physical function, that vary substantially across facilities, local markets, and states. Although volume of nursing home residents has not been tested in relation to these outcomes, this set of CMS-endorsed outcome measures has been shown to reflect varied nursing care practices and structural characteristics of facilities.[12,18,19]

Taking advantage of the CMS approach to defining nursing home outcomes and focusing on the functional status among long-term residents, this study presents a first analysis of the volume-outcome association in nursing home care. We hypothesized that high volume of

long-term care residents in a nursing facility was associated with lower rate of deteriorated physical function.

METHODS

Data Source

Our analyses relied on the 2004 and 2005 Minimum Data Set (MDS) files for all Medicare and/or Medicaid certified nursing homes,[14] which constitute over 95% of all facilities in the nation. The MDS contains over 350 data elements that record detailed information about each resident's demographics, functional status, diagnostic characteristics, and therapies received. MDS assessments for each long-term care resident are performed by nursing staff on admission, quarterly thereafter, and when the resident has a significant change in health status. Studies[20–22] have shown that MDS records, especially those used for the reported outcomes and for other CMS purposes such as case-mix adjusted reimbursement,[23] are accurate and allow for valid outcome comparisons.

The Outcome Measure and Study Sample

Our analyses focused on the CMS measure of functional decline for long-term care residents, and thus excluded postacute care patients and nursing facilities that did not provide long-term care. As described below, long-term residents available at baseline were further excluded if they were not eligible for the definition of the outcome. Facility volume was finally calculated based on eligible long-term care residents.

The definition of the outcome measure of functional decline has been described before.[14,24] Briefly, it captures a long-term care resident's change in physical function between 2 adjacent quarters, where physical function is quantified by 4 basic activities of daily living (ADL) components: bed mobility, transferring, eating, and toilet use. Each ADL component is scored on a 5-point scale, with zero standing for total independence, 1 for supervision needed, 2 for limited assistance needed, 3 for extensive assistance needed, and 4 for total dependence or if the activity did not occur. In our analyses, we used the fourth quarter of 2004 as the "baseline" quarter and the first quarter of 2005 as the "target" quarter, and operationalized the CMS definition by assigning a binary outcome variable to each long-term care resident available at baseline. The binary outcome variable equaled 1 (declined function) if the resident had at least 2 ADL components increased by 1 point (eg, from limited assistance needed to extensive assistance needed) or at least 1 ADL component increased by 2 points (eg, from total independence to limited assistance needed) between the 2 quarters, and 0 otherwise (maintained or improved function).

We then defined our study population, that is, eligible long-term care residents on whom to calculate the outcome, using CMSs exclusion criteria based on resident and facility characteristics (Table 1). When exclusions according to resident characteristics were applied, a small number of residents were excluded because of missing assessments, but the majority of excluded cases were because they were not appropriate candidates for the targeted outcome. For example, residents receiving hospice care (ie, palliative care emphasizing emotional supports and management of pain and discomfort for terminally ill patients and

their family) or with end-stage disease (ie, having 6 or fewer months to live) were not expected to perform even basic ADLs. Therefore, they were excluded from the definition of outcome.

After applying the resident-level exclusions, we further excluded small facilities (<30 eligible long-term care residents) and all of their residents from our analyses according to CMS algorithm. CMS concerned that the outcome measure for these low-volume facilities would have been inaccurate and did not publicly report these facilities' outcome rate. The final analytic sample after both resident and facility exclusions included 605,433 long-term care residents in 9336 facilities, who either had a functional decline between the fourth quarter of 2004 and the first quarter of 2005 or not.

Volume

We further defined the volume of each included facility as its total number of eligible long-term care residents for the target outcome. Because a small number of residents with missing assessments were previously excluded from the definition of the outcome and thus volume, we performed a sensitivity analysis in which these excluded "missing" records were also used to tally patient volume (but not to define the outcome). Results in the sensitivity analysis were essentially identical to those in the main analyses, and therefore are not reported here. In addition, we examined other excluded residents based on resident exclusion criteria, and confirmed that their distributions did not vary considerably across facility volume groups (results available on request).

Analyses

We first defined categorical variables for volume by ranking facilities in order of increasing volume and selecting cutoff points that most closely sorted residents into 4 equal-sized groups[3]: low volume (30–51 residents/facility), medium volume (52–69 residents/facility), medium-high volume (70–101 residents/facility), and high volume (>101 residents/facility). In bivariate analyses, we compared individual baseline characteristics (see the later text) between volume groups, using χ^2 tests for discrete variables and analysis of variance for continuous variables.

In multivariate analyses, we first identified baseline resident characteristics that may affect subsequent functional decline.[14] We combined literature review, clinical judgment, and statistical tests to determine an optimal set of patient variables for baseline risk adjustment. They included length (in weeks) between baseline and target assessments, age (in years), baseline ADL performance (independence, supervision, limited assistance, extensive assistance, and total dependence or no activity), cognitive skills for daily decision making (independent or modified independent, moderately impaired, and severely impaired), and a set of binary variables (yes/no) for short-term memory problem, rarely understand others or make self understood, depression, behavior problems in wandering, bowel incontinence, urinary incontinence, urinary tract infection, weight loss, and pressure ulcer.[14]

We estimated separate logistic regression models of functional decline that included volume (the key independent variable) as either a continuous variable, categorical variables (for the 4 volume groups defined before), or a binary variable for high-volume (>87 residents/

facility, the overall mean volume) versus low-volume (≤87 residents/facility) facilities. The unit of analyses of all regression models was each eligible long-term care resident. We did not estimate the outcome models at the facility level because we were interested in the finding of how nursing home volume of patients may affect the outcome for individual patients, rather than the aggregate outcome rate for the facility. In addition, the models for individual-level outcome allowed for more appropriate risk adjustment for each resident's baseline characteristics than the facility-level models which would base covariate adjustment on aggregate resident summaries that ignore within-facility variations. All resident-level models adjusted for the same baseline risk factors described before and, to accommodate the nesting of residents within facilities, used SAS (SAS Corp, Cary, NC) Proc Glimmix[25] to estimate random effects for nursing homes and fixed effects for resident characteristics and volume.

RESULTS

Baseline (fourth quarter of 2004) resident characteristics over volume groups are shown in Table 2. The sample of long-term care residents (n = 605,433) showed an average age of approximately 81 years, and varied functional, cognitive, and behavioral impairments. The unadjusted rate of functional decline at target assessment showed a downward trend as facility volume increased: 18.6% in the low-volume group, 17.7% in the medium or medium-high volume group, and 15.7% in the high-volume group ($x^2_{d.f.=3} = 477.5$, $P < 0.000$).

Table 3 summarizes the results of estimated volume-outcome associations from separate logistic regression models. Although estimating volume alternatively, these models incorporated a common set of baseline risk factors from MDS assessments, as listed in Table 1. This set of risk factors significantly predicted the outcome in a meaningful way. Details of the result for resident-level risk adjustment and its statistical performance can be found in an earlier study.[14] In the current study, our analyses suggested that after baseline risk adjustment for resident characteristics and the nesting of residents within facilities, volume was associated with a better outcome. Compared with low-volume facilities (30–51 residents/facility), the odds ratio of functional decline was 0.96 ($P = 0.019$) for medium volume facilities (52–69 residents/facility), 0.95 ($P = 0.013$) for medium-high-volume facilities (70–101 residents/facility), and 0.82 ($P < 0.000$) for high-volume facilities (>101 residents/facility). This positive volume effect was robust to alternative definitions of volume.

DISCUSSION

Findings in this national study support our hypothesis that high nursing home volume of long-term care residents was associated with better functional outcome measured by 4 basic ADLs. Compared with residents in low-volume facilities (30–51 residents/facility), residents in high-volume facilities (>101 residents/facility) showed an 18% decreased odds of functional decline over 3 months. This magnitude of volume benefit is similar to that found for short-term mortality after major in-hospital cardiovascular procedures such as coronary artery bypass surgery.[3]

The acute care literature has proposed 2 possible explanations of the observed volume-outcome association in hospitals-–"selective referral" and "practice makes perfect."[2] Under the first scenario, long-term care facilities with a reputation for higher quality of care would attract more residents. However, despite recent evidence of an improved situation of excess demand in the long-term care market,[26] and CMS quality reporting as an attempt to empower consumer decision making, it is still relatively uncommon for purchasers and consumers to use quality indicators in choosing long-term care facilities.[27] In addition, between-facility transfers of long-term care residents, for quality of care concerns or other reasons, are quite infrequent.[28] Thus, although quality-based purchasing represents an important goal for nursing home services,[29] it is not likely a primary explanation for the volume-outcome association found in this study.

Another important, and mostly cited, mechanism underlying the volume-outcome association in hospital care is "practice makes perfect." It is believed that cardiac surgeons performing a higher number of open heart surgeries exhibit lower risk-adjusted mortality rate, because they develop greater experience and a higher level of technical skills through more "practices" than their lower-volume colleagues.[3] Similarly, high-volume hospitals tend to possess better resources, such as well-staffed intensive care units, sophisticated respiratory care equipment, and experienced nursing staff, to achieve better postsurgical outcomes (eg, lower mortality).

One would expect that similar principles conceptualizing volume-outcome associations in hospital care might apply to the delivery of nursing home services. High-volume nursing facilities may be more likely than small ones to achieve operational efficiencies, attract and retain high-quality personnel, and invest in augmented services and targeted quality improvement procedures. For example, larger nursing facilities tend to adopt innovative models of geriatric care.[30] In addition, early studies[31–33] found that the size of a nursing facility–measured by total number of beds–might predict better resident outcomes including mortality and functional performance. Given the fact that historically most nursing homes ran close to their bed capacity,[34] these results might suggest a positive "volume" effect on outcomes.

This study has several limitations. First, the analyses we presented here are the very first step where we demonstrated a positive association between volume and long-term care quality. Because our analyses were cross-sectional, that is, focusing on long-term care residents available at baseline (the fourth quarter of 2004) and their functional change in 3 months, we were not able to determine the causal pathway between volume and outcome. Since volume per se is a proxy of quality, it is important for future research to explore various institutional, staffing, and resource attributes that contribute to the overall improved outcome found in high-volume nursing homes. Testing and clarifying the "selective referral" versus "practice makes perfect" hypothesis underling such findings would bear important clinical and policy implications, and shed light on future quality improvement initiatives for the nursing home care.

Second, our study is limited because we examined only one outcome and the result for functional decline may not be generalizable to other outcome dimensions that are important

to nursing home residents. Nevertheless, functional status is one of the key outcomes for institutionalized care, and our findings were based on a carefully designed CMS report card measure and were robust to statistical risk adjustment and alternative definitions of volume categories. The CMS definition of the functional outcome may operationally have excluded long-term care residents who died or were discharged between the baseline quarter and the follow-up quarter. If these excluded residents were not distributed evenly across facility volume groups, our estimates of the volume-outcome relationship may be biased. Nevertheless, we confirmed that these "missing" residents were small in number (ie, <0.1%) and did not vary considerably across volume groups.

These missing cases were small in number because of 2 reasons. First, we focused on existing long-term care residents and their functional change in the short term, that is, 3 months. Therefore, death or discharge may not occur frequently in this short period. Second, according to the CMS definition of this outcome, we used residents' most recent full assessments to define functional change if their assessments in the follow-up quarter were missing for any reasons such as death. The "most recent full assessments" between the baseline assessment and the regular assessment in the follow-up quarter were available for most died and discharged cases because a full MDS assessment is typically performed before a resident is discharged and per CMS requirement, is required for residents who have a significant change of health status which usually occurs before the resident dies in the facility. This CMS algorithm minimized the number of missing cases but would not bias our findings of the volume-outcome association, because we adjusted for the length of time between the baseline and the follow-up (or most recent) assessment (Table 2). However, we believe that long-term mortality and discharge status are important outcomes of nursing home residents,[35] and should be examined in future studies of volume-outcome associations.

A third limitation of the study is that because we focused on functional decline in an average of 3 months, some of the residents may have experienced only temporary functional impairment as a result of an acute illness or injury during the follow-up period, and such temporary functional impairment may be resolved afterward. Future studies are needed to examine permanent functional changes that take place in a longer term.

Fourth, the definition of the outcome excluded residents who were extremely frail such as those with an end-stage disease or in coma. The rationale of their exclusions is that short-term functional change is not a relevant outcome measure for them. Our analyses of this group of excluded residents confirmed that their distributions did not vary considerably across volume groups, and thus should not affect our findings of the volume-outcome association.

Finally, our analyses of the CMS measure excluded small facilities that had less than 30 eligible long-term care residents at baseline. The primary concern for these excluded facilities was that their outcome estimates would be inaccurate when the outcome was defined over a 3-month period. If we assume that the volume-outcome association exists for long-term care, excluding these small facilities from our analyses would bias the result toward the null hypothesis or no association. Therefore, our reported findings may represent

a conservative estimate of the true association between volume of long-term care residents and functional decline.

In summary, this study focuses on an outcome measure of physical function among long-term care residents, and suggests better outcome in high-volume nursing facilities. Additional work is necessary to understand this volume-outcome relationship in the context of nursing home care. Although current CMS outcome reports are important, they may be difficult for potential nursing home consumers to comprehend and use as a guide for facility choice. Alternatively, “volume” would be able to serve as a low cost signal of quality in the marketplace and an easy tool for consumer choice, if future work can confirm and expand our findings of the volume-outcome association.

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REFERENCES

1. Luft HS, Bunker JP, Enthoven AC. Should operations be regionalized? The empirical relation between surgical volume and mortality. N Engl J Med. 1979;301:1364–1369. [PubMed: 503167]
2. Halm EA, Lee C, Chassin MR. Is volume related to outcome in health care? A systematic review and methodologic critique of the literature. Ann Intern Med. 2002;137:511–520. [PubMed: 12230353]
3. Birkmeyer JD, Stukel TA, Siewers AE, et al. Surgeon volume and operative mortality in the United States. N Engl J Med. 2003;349:2117–2127. [PubMed: 14645640]
4. Hannan EL, Siu AL, Kumar D, et al. The decline in coronary artery bypass graft surgery mortality in New York State: the role of surgeon volume. JAMA. 1995;273:209–213. [PubMed: 7807659]
5. Glance LG, Li Y, Osler TM, et al. Impact of patient volume on the mortality rate of adult intensive care unit patients. Crit Care Med. 2006;34:1925–1934. [PubMed: 16715030]
6. Thiemann DR, Coresh J, Oetgen WJ, et al. The association between hospital volume and survival after acute myocardial infarction in elderly patients. N Engl J Med. 1999;340:1640–1648. [PubMed: 10341277]
7. Turchin A, Shubina M, Pendergrass ML. Relationship of physician volume with process measures and outcomes in diabetes. Diabetes Care. 2007;30:1442–1447. [PubMed: 17337489]
8. Lindenauer PK, Behal R, Murray CK, et al. Volume, quality of care, and outcome in pneumonia. Ann Intern Med. 2006;144:262–269. [PubMed: 16490912]
9. Saposnik G, Baibergenova A, O’Donnell M, et al. Hospital volume and stroke outcome: does it matter? Neurology. 2007;69:1142–1151. [PubMed: 17634420]
10. Birkmeyer JD, Finlayson EV, Birkmeyer CM. Volume standards for high-risk surgical procedures: potential benefits of the Leapfrog initiative. Surgery. 2001;130:415–422. [PubMed: 11562662]
11. Thompson DR, Clemmer TP, Applefeld JJ, et al. Regionalization of critical care medicine: task force report of the American College of Critical Care Medicine. Crit Care Med. 1994;22:1306–1313. [PubMed: 8045151]
12. Spector WD, Takada HA. Characteristics of nursing homes that affect resident outcomes. J Aging Health. 1991;3:427–454. [PubMed: 10115033]
13. Mukamel DB, Glance LG, Li Y, et al. Does risk adjustment of the CMS quality measures for nursing homes matter? Med Care. 2008;46:532–541. [PubMed: 18438202]
14. Li Y, Cai X, Glance LG, et al. National release of the nursing home quality report cards: implications of statistical methodology for risk adjustment. Health Serv Res. 2009;44:79–102. [PubMed: 19146565]
15. Institute of Medicine. Improving the Quality of Care in Nursing Homes. Washington, DC: National Academies Press; 1986.

16. McConnell ES, Branch LG, Sloane RJ, et al. Natural history of change in physical function among long-stay nursing home residents. Nurs Res. 2003;52:119–126. [PubMed: 12657987]
17. Thapa PB, Gideon P, Cost TW, et al. Antidepressants and the risk of falls among nursing home residents. N Engl J Med. 1998;339:875–882. [PubMed: 9744971]
18. Grabowski DC, Hirth RA. Competitive spillovers across non-profit and for-profit nursing homes. J Health Econ. 2003;22:1–22. [PubMed: 12564715]
19. Mukamel DB, Weimer DL, Spector WD, et al. Publication of quality report cards and trends in reported quality measures in nursing homes. Health Serv Res. 2008;43:1244–1262. [PubMed: 18248401]
20. Hawes C, Morris JN, Phillips CD, et al. Reliability estimates for the minimum data set for nursing home resident assessment and care screening (MDS). Gerontologist. 1995;35:172–178. [PubMed: 7750773]
21. Lawton MP, Casten R, Parmelee PA, et al. Psychometric characteristics of the minimum data set II: validity. J Am Geriatr Soc. 1998;46:736–744. [PubMed: 9625190]
22. Mor V, Angelelli J, Jones R, et al. Inter-rater reliability of nursing home quality indicators in the US. BMC Health Serv Res. 2003;3:20. [PubMed: 14596684]
23. Fries BE, Schneider DP, Foley WJ, et al. Refining a case-mix measure for nursing homes: resource utilization groups (RUG-III). Med Care. 1994;32:668–685. [PubMed: 8028403]
24. Abt Associates Inc. Quality Measures for National Public Reporting: User's Manual. Vol. 1.2. Cambridge, MA: Abt Associates Inc; 2004.
25. Littell RC, Milliken GA, Stroup WW, et al. SAS for Mixed Models. 2nd ed. Cary, NC: SAS Institute Inc; 2006.
26. Grabowski DC. Medicaid reimbursement and the quality of nursing home care. J Health Econ. 2001;20:549–569. [PubMed: 11463188]
27. Mukamel DB, Spector WD, Zinn JS, et al. Nursing homes' response to the nursing home compare report card. J Gerontol B Psychol Sci Soc Sci. 2007;62:S218–S225. [PubMed: 17673535]
28. Hirth RA, Banaszak-Holl JC, McCarthy JF. Nursing home-to-nursing home transfers: prevalence, time pattern, and resident correlates. Med Care. 2000;38:660–669. [PubMed: 10843313]
29. Abt Associates Inc. Quality Monitoring for Medicare Global Payment Demonstrations: Nursing Home Quality-Based Purchasing Demonstration. Cambridge, MA: Abt Associates Inc; 2006.
30. Banaszak-Holl J, Zinn JS, Mor V. The impact of market and organizational characteristics on nursing care facility service innovation: a resource dependency perspective. Health Serv Res. 1996;31:97–117. [PubMed: 8617612]
31. Sainfort F, Ramsay JD, Monato H Jr. Conceptual and methodological sources of variation in the measurement of nursing facility quality: an evaluation of 24 models and an empirical study. Med Care Res Rev. 1995;52:60–87. [PubMed: 10143577]
32. Winn S, McCaffree KM. Characteristics of nursing homes perceived to be effective and efficient. Gerontologist. 1976;16:415–419. [PubMed: 828602]
33. Levey S, Ruchlin HS, Stotsky BA, et al. An appraisal of nursing home care. J Gerontol. 1973;28:222–228. [PubMed: 4632519]
34. Cohen JW, Spector WD. The effect of Medicaid reimbursement on quality of care in nursing homes. J Health Econ. 1996;15:23–48. [PubMed: 10157427]
35. Decker FH. Nursing staff and the outcomes of nursing home stays. Med Care. 2006;44:812–821. [PubMed: 16932132]

TABLE 1.

Exclusion Criteria in the Definition of the CMS Measure of Physical Function for Long-term Care Residents

Resident-level exclusion
The resident was a postacute care resident at baseline assessment
The resident had total dependence or no activity on all 4 ADL items at baseline assessment
The resident was comatose or comatose status was unknown at target assessment
The resident had end-stage disease or end-stage disease status was unknown at target assessment
The resident was receiving hospice care or hospice status was unknown at the target or most recent full assessment
The measure did not trigger (resident not included in the numerator) and there is missing data on any ADL item at target assessment
Facility-level exclusion
The facility does not have chronic care admission in most recent 12 months
The facility has less than 30 residents included in the denominator of the measure

Baseline assessment in this study means MDS assessment performed in the fourth quarter of 2004; target assessment means MDS assessment performed in the first quarter of 2005.

ADL indicates activities of daily living.

TABLE 2.

Baseline Resident Characteristics and Outcome by Nursing Home Volume (n = 605,433)

Characteristic	Nursing Home Long-term Care Resident Volume*			
	Low (30–51)	Medium (52–69)	Medium-High (70–101)	High (>101)
Outcome				
Unadjusted functional decline, %	18.6	17.7	17.7	15.7
Baseline characteristic				
Length (wk) between baseline and target assessments, mean ± SD	12.8 ± 1.8	12.8 ± 1.7	12.8 ± 1.6	12.8 ± 1.5
Age (yr), mean ± SD	81.7 ± 12.5	81.4 ± 12.3	81.0 ± 12.7	79.4 ± 14.0
ADL performance—bed mobility, %				
Independent	36.8	34.1	34.8	40.1
Supervision	6.0	6.9	6.7	8.0
Limited assistance	18.1	18.6	18.2	17.3
Extensive assistance	31.2	32.7	33.4	28.6
Total dependence or no activity	7.9	7.7	6.9	6.1
ADL performance—transfer, %				
Independent	26.1	23.9	24.6	27.8
Supervision	7.2	7.9	7.8	8.9
Limited assistance	19.8	19.7	19.6	18.5
Extensive assistance	31.7	33.0	32.9	29.3
Total dependence or no activity	15.3	15.6	15.1	15.5
ADL performance—eating, %				
Independent	50.1	48.0	47.8	47.3
Supervision	26.1	27.0	26.6	26.4
Limited assistance	10.0	10.3	10.0	10.0
Extensive assistance	9.1	9.4	9.9	9.1
Total dependence or no activity	5.1	5.4	5.8	7.2
ADL performance—toilet use, %				
Independent	19.8	18.1	18.3	20.6
Supervision	6.3	6.6	6.4	6.9
Limited assistance	17.0	17.0	16.5	15.1

Characteristic	Nursing Home Long-term Care Resident Volume*			
	Low (30–51)	Medium (52–69)	Medium-High (70–101)	High (>101)
Extensive assistance	33.1	34.2	35.3	32.4
Total dependence or no activity	23.7	24.1	23.5	25.0
Short-term memory problem, %	71.9	72.6	72.3	71.0
Cognitive skills for decision making, %				
Independent or modified independent	43.4	43.2	42.9	42.6
Moderately impaired	44.9	45.4	45.6	46.1
Severely impaired	11.7	11.5	11.5	11.3
Rarely understand others or make self understood, %	4.7	4.9	5.1	5.4
Depression, %	20.4	19.5	19.0	16.7
Behavior problems in wandering, %	9.8	9.6	9.7	9.0
Bowel incontinence, %	32.5	34.8	36.8	37.2
Urinary incontinence, %	46.2	46.8	48.3	48.2
Urinary tract infection, %	9.2	9.3	9.0	7.1
Weight loss, %	7.0	7.3	7.4	7.1
Pressure ulcer, %	7.0	7.4	7.5	7.4

*$P < 0.000$ for all comparisons of resident characteristics across volume groups based on χ^2 test or analysis of variance.

TABLE 3.

Adjusted Odds Ratios for Functional Decline According to Long-term Care Resident Volume

	AOR	95% CI	*P*
Volume continuum (increase by 10)	0.98	0.98–0.99	<0.000
Volume group			
High (>101)	0.82	0.79–0.86	<0.000
Medium-high (70–101)	0.95	0.92–0.99	0.013
Medium (52–69)	0.96	0.92–0.99	0.019
Low (30–51)	1.00	—	—
Above mean volume (>87) vs. otherwise	0.88	0.85–0.91	<0.000

Multivariate logistic regression models adjusted for baseline resident characteristics as listed in Table 2, as well as the nesting of residents within nursing homes by using facility random effects.