Functionally and medically defined subgroups of nursing home populations

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The functional and health characteristics of nursing home residents in New York State using a multivariate classification procedure are examined in this article. This analysis suggested that these characteristics could be explained in terms of six dimensions. The association of these six dimensions with two existing sets of nursing home case-mix groups was analyzed in order to determine how groups based only on the health and functional characteristics of residents related to groups based primarily on measures of current service use. A number of resident characteristics were not described well by case-mix measures based only on service use, suggesting the need to modify such groups using additional sources of input.

Introduction

Describing the functional and health status characteristics of the U.S. nursing home population is difficult because of the extreme age of that population and the likelihood that residents have multiple medical problems and functional limitations. Nevertheless, such descriptions are necessary to control for functional and health status variation in assessing the adequacy of reimbursement and services for nursing home residents.

The issues involved in characterizing nursing home residents are intrinsically different from those involved in developing case-mix groups for the reimbursement of acute care hospital stays both because of the generally longer duration of nursing home stays (which implies greater potential for change in health and functional status) and because nursing homes are funded at lower levels than hospitals. In hospitals, because reimbursement for diagnosis-related group (DRG) categories under the prospective payment system (PPS) is relatively generous, the primary task is to provide incentives for efficiency. In nursing homes, with greater resource constraints (in many States the per diem Medicaid rate is modest for the complexity of cases managed), case-mix-adjusted reimbursements must provide incentives to maintain and improve the quality of care—in addition to increasing equity of per diem payments and improving access to services for heavy-care patients. This suggests that nursing home case-mix measures derived from service use should be compared with multidimensional descriptions of the health and functional status of residents to provide an independent, clinically based standard for assessing the appropriateness of the level and mix of services provided for the reimbursement and for assessing the adequacy of the outcomes of nursing home stays given those services.

Existing classification systems for nursing home reimbursement—e.g., resource utilization groups (RUGs) and patient dependency groups (PDGs)—were derived from analyses of existing service-use patterns. These systems resemble DRGs in concept and are intended for use in payment systems based on the incentive model embodied in PPS. Though these may not be ideally suited to providing incentives for maintaining (or improving) quality of care, they are based on a familiar system. A payment system explicitly designed to maintain and improve quality of care would probably have a different structure and would provide different incentives than those in PPS. As a consequence, such a reimbursement system is a significant departure from current payment systems and would therefore be difficult to implement. If the PPS fixed-price model is to be used to provide incentives to improve the equity of flat per day payments and to improve access for heavy-care patients, then it is important that it be modified to accurately describe the clinical characteristics of nursing home populations so that the effects of reimbursements on the quality of care can be monitored.

To evaluate the degree to which incentives for quality care exist in reimbursement systems modeled after PPS, the basic dimensions of nursing home resident clinical characteristics were identified using a multivariate classification procedure (the grade of membership methodology) applied to data with multiple measures of health and functional characteristics of New York nursing home residents. These dimensions describe resident attributes that might, ideally, be represented in a case-mix reimbursement system designed to provide explicit incentives to improve quality of care. Though there exist a number of operational issues in implementing multidimensional factors in a payment system, an analysis of these factors is useful to suggest improvements in detail in existing systems, to identify possible hybrid systems, or to suggest how current reimbursement systems could evolve to even logically different payment systems for future implementation that could provide more incentives for quality care. Our primary task here is to evaluate and identify resident dimensions that are relevant to quality of care and to relate how these are associated with the resident classification in two existing classification systems—i.e., resource utilization groups, version II (RUG-II) and PDGs. RUGs and PDGs stem from work at the Yale University School of Organization and Management, where PDGs were developed. Although these groups are useful for management, their primary focus is payment.

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Two sets of results are presented. The first are the multidimensional descriptions of resident characteristics derived from data from New York State nursing homes using the grade of membership method. Second, we examine how those dimensions relate to the two service-based case-mix systems (i.e., RUG-II and PDGs) and to service-use measures. This analysis, using data from New York State, a State providing one of the richest range of services to nursing home residents, represents favorable conditions for evaluating quality of care incentives in the two sets of case-mix groups. In States where fewer services are provided by Medicaid, there may be additional resident groups with deficient levels of services that might not be captured in case-mix groups identified from current service-use patterns and, consequently, have higher risks of quality of care problems.

Methods

The grade of membership (GOM) model is a multivariate pattern recognition model developed to describe complex medical diagnosis and symptom patterns because standard Bayes models for diagnosis and patient classification proved inadequate (Woodbury et al., 1978; Woodbury and Clive, 1974). GOM was designed to describe patients exhibiting considerable variation in their manifestation of such chronic disease processes as Alzheimer's disease, cancer, or stroke. Patient heterogeneity exists because of such factors as differences in the stage of disease progression or in the interaction of a person's physical state with the disease mechanism. These factors are important in describing the impact of multiple chronic physiological disease processes on elderly patient populations. The GOM model has been used successfully (by Manton et al., 1986; Woodbury and Manton, 1982; Berkman et al., 1989) to describe the characteristics of both acute and long-term care clinical and community elderly populations.

The GOM model differs from standard classification models by constructing groups or types with "fuzzy boundaries," where a person may be a member of more than one group. This permits individual heterogeneity to be represented by a relatively few analytically defined types. The AUTOGRP procedure (used for both RUG-II and PDGs) generates "fixed-boundary" groups, where there is no representation of heterogeneity within groups. An example illustrates the difference between fuzzy-boundary and fixed-boundary (discrete) groups. People could be classified on eye color by assigning them to one of three fixed-boundary groups: persons with blue eyes, persons with green eyes, and persons with brown eyes. Problems emerge when a person with hazel eyes has to be classified, i.e., a fourth group has to be created. Assigning persons with intermediate sets of characteristics is difficult when forming discrete groups for a population characterized on a large number (e.g., 62) of variables. In contrast, the GOM model can be used to describe persons as mixtures of fuzzy-boundary groups or as "pure types." A person with hazel eyes is represented as a weighted combination of types, e.g., by assigning a 50-percent GOM in the green eye and the brown eye types.

Conceptually, as seen in Strauss et al., 1979; Blazer et al., 1989; Clive et al., 1983; Woodbury and Manton, 1989, fuzzy-boundary groups have advantages in representing clinical attributes, in that the manifestation of chronic diseases in elderly patients is often quite complex. However, the logic of the GOM representation of clinical groups is different from that of the discrete group structure used in current reimbursement systems. Thus, in contrast to those systems, GOM does not have the simplicity of assigning an individual to a single category with a fixed price. Instead, a set of scores, one for each dimension, must be used to calculate a weighted price for a person. This adds complexities when determining reimbursement at the individual level and may be more difficult for providers to accept. The fuzzy-boundry groups may, however, by requiring many fewer dimensions than the discrete group models, simplify the payment structure at the population level. Resolution of the problem of acceptance of such alternative group structures is not an issue, however, in our comparison of the limited information in the discrete group systems with the more complete information in the multidimensional fuzzy-boundary groups.

In making that evaluation (i.e., of incentives in existing systems for maintaining quality of care), the GOM procedure has the advantage that types are calculated to reproduce a large number of health and functional status characteristics of patients based on the simultaneous use of information on all variables in the analysis. In AUTOGRP, clinical characteristics are entered one at a time in some selected sequence to create categories from a continuous service-use measure (e.g., length of stay or minutes of nursing care) that have the smallest within-group, but greatest between-group, variance. Because the stepwise procedure in AUTOGRP produces different groupings for different orders of inclusion of variables, expert input is required to select a solution. In GOM, types are defined according to multiple objective health criteria that produce clinically meaningful results without subjective manipulation by directly representing within-group heterogeneity.

There is no necessary relation between the clinical types identified by GOM and current reimbursement levels for those types. The independence of the definition of GOM types from the existing pattern of reimbursement and their clinical significance is necessary for assessing the relationship of quality of care to existing reimbursement mechanisms. In standard case-mix systems, because service use is used to define groups, if reimbursement changes, the group structure also changes. The GOM types, being based only on health factors, are invariant to changes in reimbursement. Consequently, they can be used to assess alternate sets of reimbursement groups defined on services.

The GOM model can be described by four quantities. The first is the representation of data for person i, as a set of J binary (0/1) variables. If a variable has multiple response levels, it is coded as L_j binary variables with one binary (0 or 1) variable for each response level. Each binary variable is designated as x_{ijl}. Each continuous variable in an analysis has to be coded into a set of L_j binary variables. Selecting the number and interval boundaries of categories to represent the information in the continuous variable is a potentially time-consuming stage in preparing a data set for analysis. Though time consuming, this recoding does not lose information contained in the continuous variable because most continuous distributions can be represented by 12 to 20 categories (Scott, 1985). Indeed, this recoding may produce gains in information over standard multivariate procedures, where the form of the distribution of the continuous variable is assumed known and only a small number of the moments of that distribution analyzed (e.g., in factor analyses only the first two moments are analyzed). In AUTOGRP, though the single dependent criterion variable is continuous, all clinical attributes used as independent variables to form trial partitions must also be transformed into categorical variables.

The second quantity is the number of types or patient dimensions (denoted as K). The goal of an analysis is to determine the smallest number of types necessary to describe all nonrandom variations in the multiple health and functional measures. In contrast, AUTOGRP minimizes the unexplained variation of a single dependent service-use variable using partitions selected stepwise from a set of discretely coded clinical variables.

The third and fourth quantities are the coefficients used to predict the x_{ijl}. The first, λ_{kjl}, is the probability that a person who is exactly like the kth type will have the lth response to the jth variable. These coefficients describe the substantive nature of types in terms of their clinical attributes. The second, g_{ik}, are scores representing the degree to which the ith person is represented by the kth type. The g_{ik} must sum to 1.0 for a person and adopt values between 0 and 1.0. With these definitions, the model predicts the probability that the ith person has the lth response to the jth variable, as

$$\text{PROBABILITY } [x_{ijl} = 1.0] = \sum_k g_{ik}\, \lambda_{kjl}.$$

The coefficients are estimated using maximum likelihood procedures that produce estimators with known statistical properties (Tolley and Manton, 1990a; 1990b). In addition, the ability of the model to describe the health and functional variables (the x_{ijl}) is measured by the X^2 generated from the ratio of likelihood values for models with k and $k+1$ types. This is a far more stringent test of fit than R^2 (which is not defined for multiple discrete variables) in that all nonrandom variations of the J health and functional variables must be explained (equivalent to an R^2 for these multiple measures equaling 100 percent except for sampling). An R^2 measure is not appropriate for the analyses proposed to describe the multiple health and functional characteristics describing residents.

Though not the prime purpose of this analysis, one can estimate a regression where service use is predicted as a function of the GOM scores or

$$\text{Patient Costs } = \bar{x}_1 g_{i1} + \bar{x}_2 g_{i2} + \ldots + \bar{x}_k g_{ik} + e.$$

The regression coefficient $\bar{x}_k$ represents the average costs for persons of type k (i.e., $g_{ik} = 1.0$). For a person who is a mixture of types, one has to calculate the weighted average of the costs of the types. For persons not included in the GOM analysis, individual x_{ijl} values can be used to calculate g_{ik}'s.

In addition, one need not be restricted to empirically determined prices. Prices for types can be modified to reflect the resources needed to provide quality care. For example, a simple approach (which maintains the PPS framework) to providing incentives for quality care would be to conduct analyses forming the K types of health and functional status and to use external (nongrouping) variables that represent a selected outcome for each facility in the analysis. For example, if there were 10,000 residents (I = 10,000) in 50 facilities, 50 external variables representing mortality in each facility could be included in the analysis to see which facilities had the lowest mortality rate (i.e., each λ_{kjl} for this external variable would provide the probabiliy of death for 1 of the 50 facilities for each of the k types of resident; other measures of adverse outcomes such as decubiti also could be used) for different resident types. Then one could identify the costs from the best 10 facilities for, say, the limited impaired (either from a regression, the X_l, or from cost variables used as external variables in the GOM analysis; use of GOM to estimate reimbursement levels for resident types in facilities has the advantage of not assuming linearity or normality), and costs from other facilities with the best outcomes for other types. This does not calibrate reimbursement for a resident type to the average expenditures for all facilities, which may be low or high relative to the optimal level, but to the expenditures associated with the best health outcomes for the kth relevant type—which need not be in the highest cost facilities. In particular, in identifying the nursing homes with the best outcomes, it may sometimes be that cost is not the key discriminatory factor. In this case, one could conduct a second GOM analysis of nursing home characteristics to see what structural factors (independent of patient reimbursement) contribute to the best outcomes. In this situation, a simple per diem reimbursement formula might not be adequate—one might have to provide incentives for certain structural features (e.g., specific size or location near certain medical facilities) for the management of specific types of nursing home residents.

Data

In order to identify GOM types of nursing home residents, it is necessary to have multivariate health and functional status data. The data would, ideally, be a sample of nursing home residents for a State that provides a high level of services to nursing home residents and includes a wide range of descriptors such as limitations in activities of daily living (ADLs), instrumental activities of daily living (IADLs), cognitive ability, behavior, principle diagnosis, secondary diagnoses, and measures of resource use. A data set with these characteristics was collected by New York State to develop one of the AUTOGRP-based case-mix systems, RUG-II. RUG-II is currently used to determine per diem nursing home payments in the New York Medicaid Program. A sample of 3,427 Medicaid nursing home residents was drawn for the New York case-mix project with heavy-care residents oversampled.

Grade of membership results

GOM results are presented in Table 1. The first column describes both variables and their response levels, e.g., the first variable is "Primary diagnosis" and the first response is a primary diagnosis of cancer. The second column contains the frequency of the response in the sample (e.g., 1.4 percent have cancer and 17.8 percent have heart disease as primary diagnoses). The 21 diagnoses comprise a single multinominal variable ($L_j = 21$) because a person can have only one primary diagnosis. Thus, the frequencies add to 1.0.

In contrast, "Associated conditions," the second set of variables, represent 29 independent binary variables because a person can have multiple conditions, e.g., the probability of cancer as an associated condition is 3.3 percent; the probability of heart disease is 50.6 percent. In the remainder of column 1, we present other health and functional characteristics used to define the GOM dimensions.

Table 1

Grade of membership results for 62 variables, by type of nursing home resident: New York State

Variable	Frequency	Type of nursing home resident: Limited impaired (1)	Oldest-old, deteriorating (2)	Acute and rehabilitative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
1. **Primary diagnosis**							
Cancer	1.43	0.66	1.79	3.01	1.39	0.00	1.32
Heart disease	17.79	35.56	62.83	9.48	0.00	0.00	0.00
Stroke	10.78	0.00	0.00	18.56	0.00	19.46	20.72
Diabetes	4.05	7.77	8.57	1.10	9.47	0.00	0.00
Arthritis	5.94	8.56	14.39	11.10	0.00	0.00	0.00
Renal problems	0.64	0.00	0.00	1.74	0.00	0.06	1.44
Digestive problems	0.70	0.00	1.52	2.27	0.00	0.00	0.00
Hip fracture	1.92	0.00	0.00	9.52	0.00	0.00	0.00
Liver and gall bladder problems	0.12	0.42	0.00	0.00	0.00	0.34	0.00
Alzheimer's disease or senile dementia	15.29	12.07	0.00	0.00	22.68	42.50	20.07
Other neurological problems	10.30	0.00	0.00	24.64	0.00	0.00	27.32
Chronic respiratory problems	1.64	6.79	3.30	0.00	0.00	0.00	0.00
Other rerspiratory problems	0.61	0.00	1.37	0.81	0.00	0.00	1.17
Infectious disease	0.34	0.00	1.43	0.00	0.00	0.70	0.00
Other endocrine problems	0.18	0.00	0.00	0.00	1.46	0.00	0.00
Metabolic disorder	0.34	0.20	0.00	0.00	0.00	0.00	1.55
Blood disorder	0.49	0.00	3.05	0.00	0.00	0.00	0.00
Mental disorder	18.40	22.20	0.00	0.00	44.54	36.94	17.83
Atherosclerosis	2.56	0.00	0.00	0.00	20.46	0.00	0.00
Other circulatory problems	1.22	0.00	0.00	6.05	0.00	0.00	0.00
Other	5.27	5.78	1.75	11.72	0.00	0.00	8.59
Associated conditions							
2. Cancer	3.33	4.37	14.32	2.36	4.93	0.00	0.00
3. Heart disease	50.60	47.13	100.00	49.95	32.83	62.03	21.23
4. Stroke	16.37	6.07	28.96	17.67	13.49	13.43	22.95
5. Diabetes	12.26	5.96	25.80	17.43	27.91	5.20	7.46
6. Arthritis	22.03	19.36	100.00	12.28	4.25	19.11	0.00
7. Renal problems	6.39	0.00	0.00	0.00	0.00	0.00	29.95
8. Digestive problems	7.56	4.55	55.16	0.00	0.00	0.00	0.00
9. Hip fracture	4.61	2.54	0.00	6.28	0.00	7.21	6.73
10. Liver and gall bladder disease	1.02	1.34	7.00	0.00	0.00	0.00	0.00
11. Alzheimer's disease or senile dementia	8.17	0.00	0.00	0.00	61.62	0.00	10.01
12. Other neurological problems	16.49	0.00	100.00	0.00	0.00	0.00	0.00
13. Chronic respiratory problems	5.16	7.59	23.40	0.00	6.82	2.61	0.00
14. Other respiratory problems	1.93	1.57	0.00	1.38	0.00	3.33	3.10
15. Urological problems	6.39	0.00	0.00	0.00	0.00	0.00	29.95
16. Infectious disease	75.72	100.00	0.00	100.00	100.00	100.00	100.00
17. Other endocrine problems	2.66	2.63	15.70	2.20	0.00	0.00	0.00
18. Metabolic disorder	2.31	3.42	5.00	2.11	6.36	0.00	0.71
19. Blood disorder	6.24	0.00	51.34	0.00	0.00	0.00	0.00
20. Mental disorder	17.54	0.00	0.00	0.00	100.00	0.00	0.00
21. Eye problems	12.28	0.00	100.00	0.00	0.00	0.00	0.00
22. Ear problems	2.83	0.00	31.94	0.00	0.00	0.00	0.00
23. Atherosclerosis	5.46	0.00	27.35	0.00	0.00	7.83	3.82
24. Other circulatory problems	5.25	1.55	29.66	8.49	0.00	0.00	0.00
25. Skin problems	2.60	0.00	14.27	0.00	2.14	0.00	4.46
26. Fractured extremities	1.81	0.00	0.00	3.62	0.00	0.00	5.60
27. Comatose	1.20	0.00	0.00	0.00	0.00	0.00	6.37
28. Terminally ill	1.32	0.00	0.00	1.79	0.00	0.00	4.95
29. Alcohol abuse	3.17	4.77	0.00	0.00	26.64	0.00	0.00
30. Drug abuse	0.26	0.00	0.00	0.00	3.14	0.00	0.00

See footnote at end of table.

Table 1—Continued

Grade of membership results for 62 variables, by type of nursing home resident: New York State

Variable	Frequency	Type of nursing home resident: Limited impaired (1)	Oldest-old, deteriorating (2)	Acute and rehabilitative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
Limitations							
31. Vision:							
No loss	74.53	100.00	0.00	100.00	100.00	91.92	54.39
Moderate loss	19.03	0.00	63.05	0.00	0.00	8.08	45.61
Servere loss	6.44	0.00	36.95	0.00	0.00	0.00	0.00
32. Hearing:							
No loss	80.22	100.00	0.00	100.00	100.00	100.00	100.00
Moderate loss	15.26	0.00	77.15	0.00	0.00	0.00	0.00
Severe loss	4.52	0.00	22.85	0.00	0.00	0.00	0.00
33. Verbal expression:							
No difficulty	66.43	100.00	100.00	91.11	83.53	51.13	0.00
With difficulty	23.72	0.00	0.00	8.89	16.65	48.87	48.31
Totally impaired	9.85	0.00	0.00	0.00	0.00	0.00	51.69
34. Reception:							
No difficulty	57.50	100.00	47.26	100.00	0.00	40.18	0.00
With difficulty	34.36	0.00	52.74	0.00	100.00	59.82	38.89
Totally impaired	8.14	0.00	0.00	0.00	0.00	0.00	61.11
35. Diet:							
Regular	19.56	34.80	0.00	28.35	18.81	26.83	0.19
Other	80.44	65.20	100.00	71.65	81.19	73.17	99.81
36. Decubiti:							
None	88.79	100.00	100.00	93.73	100.00	100.00	52.33
Single	9.57	0.00	0.00	6.27	0.00	0.00	39.88
Multiple	1.64	0.00	0.00	0.00	0.00	0.00	7.79
37. Discoloration	6.02	0.00	59.66	0.00	0.00	0.00	0.00
38. Edema	15.16	0.00	93.48	13.38	21.33	0.00	4.90
39. Weight loss	13.61	0.00	53.30	9.86	42.09	4.39	10.14
40. Severe pain	8.03	4.19	25.41	20.44	9.77	0.00	0.00
41. Contractures	22.49	0.00	0.00	0.00	0.00	0.00	97.90
42. Dyspnea	4.71	0.00	46.50	0.00	0.00	0.00	0.00
43. Mobility:							
No impairment	21.65	100.00	0.00	0.00	0.00	0.00	0.00
With help	24.37	0.00	0.00	62.36	0.00	38.43	0.00
Wheelchairfast	38.11	0.00	100.00	37.64	0.00	61.57	36.15
Chairfast	14.74	0.00	0.00	0.00	0.00	0.00	59.27
Bedfast	1.14	0.00	0.00	0.00	0.00	0.00	4.58
44. Transfer:							
No impairment	29.51	100.00	0.00	0.00	0.00	0.00	0.00
With help	40.11	0.00	100.00	100.00	0.00	100.00	0.00
Bedfast	30.39	0.00	0.00	0.00	0.00	0.00	100.00
45. Eating:							
No loss	22.12	100.00	0.00	0.00	0.00	0.00	0.00
With supervision	55.85	0.00	100.00	100.00	100.00	100.00	0.00
Totally impaired	22.03	0.00	0.00	0.00	0.00	0.00	100.00
46. Dressing:							
No impairment	13.22	62.72	0.00	0.00	0.00	0.00	0.00
With supervision	36.68	37.28	100.00	100.00	0.00	0.00	0.00
Totally impaired	50.10	0.00	0.00	0.00	0.00	100.00	100.00
47. Bathing:							
No impairment	2.25	10.12	0.00	0.00	0.00	0.00	0.00
With assistance	42.88	89.88	100.00	100.00	0.00	0.00	0.00
Totally impaired	54.87	0.00	0.00	0.00	0.00	100.00	100.00
48. Toileting:							
No impairment	27.37	100.00	0.00	0.00	0.00	0.00	0.00
With help	24.25	0.00	100.00	100.00	0.00	100.00	0.00
Totally impaired	48.38	0.00	0.00	0.00	0.00	100.00	100.00
49. Bladder control:							
Continent	39.31	100.00	0.00	100.00	0.00	0.00	0.00
Incontinent	51.59	0.00	100.00	0.00	100.00	100.00	58.92
Indwell	7.27	0.00	0.00	0.00	0.00	0.00	32.78
Extern	1.84	0.00	0.00	0.00	0.00	0.00	8.29
50. Bowel:							
Continent	46.57	99.11	0.00	99.17	0.00	0.00	0.00
Incontinent	53.38	0.00	0.00	0.00	0.00	100.00	100.00
Colostomy	1.05	0.89	100.00	0.83	100.00	0.00	0.00

See footnote at end of table.

Table 1—Continued
Grade of membership results for 62 variables, by type of nursing home resident: New York State

Variable	Frequency	Type of nursing home resident: Limited impaired (1)	Oldest-old, deterio-rating (2)	Acute and rehabili-tative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
51. Personal hygiene:							
No impairment	12.32	54.55	0.00	0.00	0.00	0.00	0.00
With supervision	25.84	45.56	100.00	100.00	0.00	0.00	0.00
With assistance	61.84	0.00	0.00	0.00	100.00	100.00	100.00
52. Learning:							
No impairment	32.80	91.94	0.00	84.46	0.00	0.00	0.00
With difficulty	49.09	8.06	100.00	15.54	100.00	93.40	0.00
Totally impaired	18.11	0.00	0.00	0.00	0.00	6.60	100.00
53. Patient wanders	9.48	0.00	0.00	0.00	94.33	17.90	0.00
54. Patient verbally abusive	34.90	0.00	0.00	0.00	100.00	0.00	0.00
55. Patient physically aggressive	16.95	0.00	0.00	0.00	100.00	0.00	0.00
56. Severe depression	7.36	0.00	0.00	0.00	100.00	0.00	0.00
57. Hallucinations	6.13	0.00	0.00	0.00	100.00	0.00	0.00
58. Paranoia	7.65	0.00	0.00	0.00	100.00	0.00	0.00
59. Patient withdrawn	32.11	0.00	86.14	0.00	100.00	0.00	47.16
60. Delusion	4.41	0.00	0.00	0.00	82.83	0.00	0.00
61. Hoarding	5.66	7.25	0.00	7.81	39.77	0.00	0.00
62. Manipulative	11.97	0.00	0.00	36.44	78.97	0.00	0.00

SOURCE: Duke University Center for Demographic Studies: Tabulated from New York State Medicaid data.

The remaining columns in Table 1 contain the λ_{kjl} probabilities describing the types. Each is the probability that an individual who is exactly like a type has the particular attribute. Thus, the probability of a person exactly like Type 1 having heart disease as a primary diagnosis is 35.6 percent, and for Type 2, it is 62.8 percent—i.e., both Type 1 and Type 2 are more likely to have heart disease than the other types are. The diseases and conditions that are strongly associated with a type define its substantive nature.

In Table 2, we present λ_{kjl} estimates for external variables that measure the association between GOM types defined on medical and functional status variables and demographic, admission type, therapy, and service-use variables not used to define the types.

From the data in Tables 1 and 2, six types can be described:

- Type 1, "Limited impaired" residents, are individuals with heart disease, diabetes, arthritis, and some cognitive and mental impairments as primary diagnoses. They are not characterized by higher probabilities of associated conditions (except infectious diseases and alcohol consumption), and they have few ADL deficiencies and sensory problems. In Table 2, we see that their primary condition is likely to last more than 5 years, but they have low levels of hospital use. They are more likely to be admitted from home because they lacked home care even though they require less time from a registered nurse (RN), a licensed practical nurse (LPN), or an aide than other types do.

This type of resident is relatively physically healthy and functionally intact, but apparently lacked the necessary social resources to cope with "mild" health and cognitive problems at home. This type of resident might be a candidate for home and community-based care; and, thus, it might be appropriate to have a reimbursement system with incentives for discharge and home maintenance for this type of resident.

- Type 2, the "Oldest-old, deteriorating" residents, are very old individuals (all older than 85 years) who are very frail and are characterized by multiple medical problems that include cancer, heart disease, arthritis, stroke, diabetes, digestive problems, neurological problems, and pulmonary problems. In contrast to Type 1, they report no dementia. These people have an elevated probability of being hospitalized and have moderate levels of ADL limitation. They have severe sensory problems and weight loss. They require more care than all the other types except Type 6. Needs include bowel treatment, laboratory tests, oxygen therapy, reality orientation, sensory stimulation, monitoring intake and outtake of fluid, and pain control.
- Type 3, "Acute and rehabilitative" residents, are acutely ill individuals most often admitted from hospitals for rehabilitation. Medical problems include hip fracture, stroke, arthritis, and neurologic conditions—but with fewer associated conditions than Type 2. Their medical status is chronic but stable with moderate ADL impairment. This type is often discharged home after a short stay because of good informal support. Services received, consistent with rehabilitation, include occupational therapy and ambulation training.
- Type 4, "Behavioral problem" residents, are individuals with mental and behavior problems, including alcohol and drug abuse. Some have additional chronic conditions and complicating illnesses. Their most frequent primary diagnosis is mental illness with deterioration expected. This type is most likely to be restrained by chemical or other means. Service use is higher than average, especially aide time. Other services used include

Table 2
Grade of membership results for nursing home residents, by type of resident and selected characteristics: New York State

Characteristic	Frequency	Limited impaired (1)	Oldest-old, deteriorating (2)	Acute and rehabilitative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
		Type of nursing home resident					
Demographic							
Sex:							
Male	21.69	27.44	16.43	22.93	30.60	16.26	19.67
Female	78.31	72.56	83.57	77.07	69.40	83.74	80.33
Source of payment:							
Medicaid	78.50	82.41	99.55	69.43	63.30	75.12	81.73
Medicare	2.36	0.00	0.39	10.05	0.00	0.68	1.96
Private	18.07	16.22	0.06	17.54	36.10	23.85	15.72
Other	1.06	1.38	0.00	2.98	0.59	0.35	0.60
Marital status:							
Married	15.04	11.83	0.00	12.66	17.64	16.85	26.75
Alone	84.96	88.17	100.00	87.34	82.36	83.15	73.25
Age:							
Under 55 years	3.35	1.57	0.00	4.42	0.00	0.19	12.07
55-64 years	3.99	4.04	0.00	5.65	8.32	1.10	6.92
65-74 years	10.63	13.15	0.00	17.82	17.72	6.20	11.25
75-84 years	31.59	40.60	0.00	37.46	28.68	36.32	37.38
85-94 years	42.84	37.83	77.44	29.61	40.30	47.26	29.50
95 years or over	7.60	2.80	22.56	5.03	4.99	8.94	2.88
Admission							
Length of stay:							
Less than 1 month	5.59	4.60	1.90	15.66	0.80	5.55	2.04
1-6 months	12.41	12.15	5.77	30.91	0.00	13.53	4.65
7-12 months	10.74	11.45	15.13	12.25	12.10	11.90	4.29
13-24 months	17.15	17.93	9.28	14.30	30.90	23.70	9.86
25-48 months	23.24	22.33	32.49	13.46	26.17	25.14	24.21
49-72 months	13.35	11.08	12.16	5.70	20.92	10.58	22.55
73 months or more	17.51	20.44	23.27	7.72	9.12	9.59	32.39
Patient admission location:							
Home	23.49	42.35	25.09	16.89	17.78	19.88	15.98
Nursing	22.88	21.57	25.82	14.40	31.46	30.52	18.27
Hospital	52.79	34.57	49.09	67.84	50.73	48.61	64.95
Other	0.85	1.51	0.00	0.88	0.03	0.99	0.80
Reason for admission:							
Mental	22.84	20.82	0.00	0.00	77.91	33.97	25.81
Physical	47.70	30.40	55.65	81.58	0.00	41.95	52.37
No Care	15.62	23.55	17.11	9.15	22.09	15.71	10.62
Other	13.83	25.22	27.24	9.26	0.00	8.36	11.20
Primary condition duration:							
Less than 1 year	12.62	3.54	23.12	37.44	0.00	2.77	9.25
1-5 years	35.56	33.39	10.62	31.10	54.99	49.92	31.40
6 years or more	51.82	63.07	66.27	31.46	45.01	47.32	59.35
Primary prognosis:							
Acute	4.26	0.58	8.00	10.44	0.00	1.68	5.17
Chronic	4.35	4.02	3.94	15.31	0.00	0.92	0.73
Stable	46.87	66.38	25.30	54.22	0.00	51.80	47.14
Deteriorating	44.52	29.03	62.76	20.04	100.00	45.60	46.96
Number of days hospitalized:							
None	60.30	76.54	46.34	33.79	79.36	65.54	62.52
1-30	24.46	15.78	38.76	36.14	9.33	19.63	26.36
31 or more	15.25	7.68	14.90	30.07	11.31	14.83	11.13
Number of times hospitalized:							
None	65.54	84.27	47.80	39.77	81.14	71.28	67.57
1	25.34	11.05	43.00	45.00	7.69	23.47	20.94
2-3	8.46	4.21	7.72	14.70	9.33	4.86	11.23
4 or more	0.66	0.47	1.47	0.53	1.83	0.39	0.26
Physical restraint:							
Routine	74.06	3.28	100.00	76.93	90.25	99.58	99.52
Nonroutine	0.61	0.00	0.00	1.37	3.41	0.42	0.00
None	25.33	96.72	0.00	21.70	6.34	0.00	0.48
Chemical restraint:							
Routine	17.16	2.09	6.21	6.45	87.61	17.36	10.05
Nonroutine	1.72	0.00	0.00	0.00	12.39	0.28	1.82
None	81.12	97.91	93.79	93.55	0.00	82.36	88.13

See footnote at end of table.

Table 2—Continued

Grade of membership results for nursing home residents, by type of resident and selected characteristics: New York State

		Type of nursing home resident					
Characteristic	Frequency	Limited impaired (1)	Oldest-old, deteriorating (2)	Acute and rehabilitative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
Other restraint:							
Routine	6.51	0.00	0.00	0.28	17.39	6.32	18.68
Nonroutine	0.32	0.00	0.00	0.00	2.18	0.46	0.28
None	93.17	100.00	100.00	99.72	80.43	93.22	81.04
Informal support resources:							
Excellent	41.47	44.62	2.02	54.55	0.00	51.50	58.83
Limited	28.11	30.79	35.37	29.25	18.41	37.44	8.81
Minimal	21.81	12.02	42.50	13.07	66.78	8.25	23.02
None	8.60	12.57	20.10	3.13	14.81	2.80	9.35
RN time:							
0-9 minutes	52.43	81.93	61.81	45.03	59.85	55.67	27.43
10-29 minutes	33.86	16.53	27.78	43.18	27.76	36.79	40.21
30-59 minutes	9.43	1.54	6.80	9.38	8.89	6.33	19.71
60-89 minutes	3.48	0.00	3.60	2.10	2.71	0.00	10.95
90 minutes or more	0.80	0.00	0.00	0.31	0.79	1.21	1.70
LPN time:							
0-9 minutes	45.50	69.52	30.42	48.17	31.37	52.11	26.21
10-29 minutes	37.60	27.49	53.42	40.41	49.77	37.06	30.97
30-59 minutes	12.43	2.99	12.30	9.35	15.53	10.04	26.51
60-89 minutes	2.97	0.00	2.62	1.93	3.33	0.79	9.49
90 minutes or more	1.50	0.00	1.24	0.15	0.00	0.00	6.82
Aide time:							
0-9 minutes	5.28	22.04	0.00	1.04	0.00	0.00	0.59
10-29 minutes	14.74	55.07	10.11	6.31	0.00	2.06	1.27
30-59 minutes	21.14	21.75	4.89	44.85	40.95	13.93	6.90
60-89 minutes	25.04	0.96	24.00	33.44	50.81	42.98	14.78
90-119 minutes	21.11	0.18	53.98	10.65	8.23	30.92	37.07
120 minutes or more	12.68	0.00	7.02	3.72	0.00	10.11	39.39
Therapy							
Physical therapy	19.38	6.51	21.73	48.15	0.00	17.86	16.68
Occupational therapy	8.81	1.44	10.62	21.37	2.82	9.97	5.45
Bowel treatment (not impaction)	28.86	0.42	53.20	23.58	79.01	23.44	41.49
Decutitus ulcer skin care	10.21	0.00	4.70	4.69	0.00	0.64	42.97
Bowel impaction care	7.82	0.00	3.19	3.47	6.46	10.06	20.13
2 or more laboratory tests	11.64	3.42	33.68	14.91	5.26	5.43	15.10
Oxygen therapy	1.34	0.25	10.03	0.00	0.00	0.00	1.17
Control for severe pain	5.89	1.00	16.36	16.14	8.98	0.00	1.20
Range of motion treatment	47.33	0.88	69.91	45.89	0.00	57.90	88.86
Reality orientation	28.16	0.00	42.45	12.05	100.00	35.57	27.01
Sensory stimulation	15.82	0.19	44.34	5.47	31.71	11.07	30.06
Preventative skin care	59.38	1.09	86.48	47.46	74.21	76.73	95.28
Splint assistance	5.22	0.22	1.66	7.49	0.00	2.78	15.15
Sterile dressing	7.76	0.30	14.37	8.07	3.16	0.00	22.78
Ambulation and gait training	15.70	0.80	18.12	37.05	0.00	31.86	0.00
Bowel and bladder training	5.28	0.00	9.71	5.51	5.75	12.48	0.00
Dressing and grooming training	3.47	0.70	0.00	16.93	3.31	0.00	0.00
IADL training	1.63	0.27	1.25	7.52	0.00	0.33	0.00
Meal training and use of aids	2.22	0.00	0.00	6.65	5.19	2.46	0.00
Self-transfer training	9.31	0.35	0.00	32.27	0.00	14.58	2.89
Turning and positioning	39.36	0.00	0.00	15.77	0.00	51.33	97.64
Wound and lesion care	8.84	1.01	22.82	10.68	9.09	0.00	17.93
Other general care	13.98	10.64	9.82	23.90	13.05	5.64	20.02
Intake and outtake of fluids	10.01	0.00	33.09	0.37	1.30	3.14	31.98
Required extra care (not recorded)	14.74	8.16	26.45	26.49	33.21	0.49	13.10

NOTES: RN is registered nurse. LPN is licensed practical nurse. IADL is instrumental activity of daily living.

SOURCE: Duke University, Center for Demographic Studies: tabulated from New York State Medicaid data.

reality orientation and sensory stimulation. Because of its care requirements, this type might be treated in specialized facilities.

• Type 5, "Dementia" residents, are relatively old individuals with deteriorating mental capacity. Senile dementia is characteristic, as are stroke and other mental problems. Deficiencies in ADL are serious; only Type 6 residents are more impaired. Mobility, incontinence, and bowel control are problems, and they use more RN and aide time than average, but not more LPN time. Services include preventative skin care, ambulation training, transfer training, and help in turning and positioning.

• Type 6, "Severely impaired" residents, are the most resource intensive and are relatively young, often terminally ill, and severely impaired. They have the longest stays and are admitted from hospitals for physical problems, including stroke, renal failure, respiratory, and neurological problems. This type suffers from the most severe ADL deficiencies and from decubiti. They are provided help with impacted bowels, skin care, sensory stimulation, sterile dressing, splint care, turning and positioning, monitoring intake and outtake of fluid, and wound care.

Because persons have scaled scores on each dimension, the decline of an individual over time can be described as movement from Type 1 ("Limited impaired") to one of the sicker types, e.g., Type 5. Movement between types (described by a decline in the g_{ik} score for the type that one is moving away from and an increase in the g_{ik} for the type that one is moving toward) indicates processes of either decline or recovery, depending on the patterns of changes in the g_{ik}'s.

Descriptions of two case-mix systems

To describe the two nursing home case-mix systems, we first discuss their generation by the AUTOGRP procedure. AUTOGRP is an interactive version of the Automatic Interaction Detection Program developed at the University of Michigan. AUTOGRP explains the variation of a single continuous criterion variable, generally a measure of resource use by recursive partitioning (i.e., decomposing the dependent variable into categories using trial and error decompositions based on the classes of discrete independent variables) on patient descriptors (ADL, diagnoses, age). For each independent variable, a partition of the criterion (dependent) variable (Mills et al., 1976) is produced that maximizes the ratio of between- to within-group variance. Because variables are introduced one at a time and the partition at a step may not be optimal, group definitions may change with the order of inclusion of variables.

AUTOGRP was designed to be interactive so it can be used in a process for generating groups that involve subjective input. Specifically, medical professionals and other researchers can change the results of AUTOGRP so that the partitions are more clinically meaningful or that other case-mix adjustments can be implemented (e.g., promoting use of additional therapies or increasing access for heavy-care patients). Thus, a set of groups suggested by AUTOGRP and defined (e.g., on principal diagnosis) might be modified by moving conditions from one group to another, adding codes not present in the data, collapsing or adding groups, etc. The researcher also decides the order of inclusion of the independent variables, e.g., in developing DRG's, the presence of a major operating room procedure was the first division for most major diagnostic categories.

Both reimbursement systems to be discussed (RUG-II and PDGs) were generated with AUTOGRP. Both employed resource use at the patient level as the dependent variable. Both modified AUTOGRP partitions using clinical judgment. Both RUG-II and PDGs were derived from data sets that included similar patient descriptors and measures of resource use—i.e., nursing time.

The RUG-II classification system was developed for use in the Medicaid case-mix reimbursement system for New York State, where it has been in operation since January 1986 (Fries and Cooney, 1985). The RUG-II groups have two components. In the first, residents are classified into five groups: (1) heavy rehabilitation, (2) special care, i.e., residents with serious medical problems requiring specific services, such as chemotherapy, transfusions, treatment for dehydration, or a physician's visit at least once a week, (3) clinically complex, (4) severe behavioral problems, and (5) reduced physical functioning (all other residents). Residents are assigned to the most resource-intensive group for which they qualify. The second component of the RUG-II system is an ADL index that sums severity scores for three individual ADL variables (toileting, eating, and transfer) scaled from one to three (or four).

Using PDG (Fetter, 1987), a resident is classified on five attributes. The first attribute is whether or not the residents are fed entirely by others. If residents are fed by others, they are assigned to the heaviest care group. If residents feed themselves, it is ascertained if they are dressed by others. If dressed entirely by others, they are classified into the second most intensive care group. If not, it is determined if residents require help in transferring. If yes, they are assigned to group three. Next, it is determined if residents are incontinent or require help in dressing. If they have either problem, they are assigned to the fourth group. If they have none of these problems, they are classified into the lightest care group.

Association of multivariate patient dimensions

We compared the assignment of patients into RUGs and PDGs with multivariate analyses of health variables by using the RUG and the PDG assignments as external (nongrouping) variables in a GOM analysis. The external λ_{kjl} describing the association of the RUG and PDG categories with the six resident types identified by GOM are presented in Table 3.

In Table 3, the "Limited impaired" (Type 1) are associated with RUG-II 5 and RUG-II 12, the groups with the lowest level of impairment of the clinically complex and physical RUGs. Thus, though not clinically complex, Type 1 residents are partly assigned to the least impaired of the clinically complex group because of their low level of functional impairment. Type 2 residents, the "Oldest-old, deteriorating" group, are associated with the middle two (in terms of impairment, RUG-II 6 and 7) clinically complex groups. Though Type 2 residents are clinically complex, they are only moderately impaired—they are not associated with RUG-II 8. Type 3 ("Acute and rehabilitative") residents are associated with several RUGs including rehabilitation RUG-II 3 and 4, clinically complex RUG-II 5 and 6, and physical RUG-II 12-14 (low impairment). Thus, in the GOM analysis, physical requirements for rehabilitation span multiple RUG domains. Type 4 ("Behavioral problem") residents fall clearly into the two lowest levels of the severe behavior RUG-II 9 and 10. In contrast, Type 5 residents, the "Dementia" group, fall into the physical, behavior, and clinically complex RUGs. Thus, residents with specific medical or functional profiles are associated with several RUG-II groups. The younger, "Severely impaired" residents (Type 6) have a similar set of associations.

Table 3
Nursing home residents, by type of impairment and RUG-II and PDG assignments, New York State

Variable	Frequency	Limited impaired (1)	Oldest-old, deteriorating (2)	Acute and rehabilitative (3)	Behavioral problems (4)	Dementia (5)	Severely impaired (6)
RUG-II							
RUG-II 1	1.66	0.00	0.00	1.86	0.00	1.40	4.30
RUG-II 2	5.92	0.00	0.00	0.03	1.08	0.17	24.16
RUG-II 3	1.98	1.86	0.00	9.21	0.00	0.00	0.00
RUG-II 4	3.56	0.00	0.00	13.01	0.00	4.23	1.74
RUG-II 5	3.94	11.36	0.00	6.33	0.00	0.00	0.00
RUG-II 6	6.48	0.00	77.95	17.77	3.58	11.55	0.00
RUG-II 7	4.96	0.00	22.05	0.00	0.00	2.31	17.94
RUG-II 8	1.08	0.00	0.00	0.00	0.00	0.00	4.52
RUG-II 9	4.00	1.85	0.00	0.00	36.37	0.00	0.00
RUG-II 10	8.75	0.00	0.00	0.00	55.91	13.95	0.00
RUG-II 11	3.94	0.00	0.00	0.00	1.75	0.00	15.80
RUG-II 12	24.98	84.93	0.00	20.02	0.00	0.00	0.00
RUG-II 13	2.92	0.00	0.00	12.98	1.32	2.77	0.00
RUG-II 14	18.30	0.00	0.00	18.80	0.00	63.62	0.00
RUG-II 15	5.98	0.00	0.00	0.00	0.00	0.00	25.07
RUG-II 16	1.55	0.00	0.00	0.00	0.00	0.00	6.48
PDG							
One	11.26	40.21	0.00	0.00	0.00	0.00	0.00
Two	16.75	59.79	0.00	0.00	0.00	0.00	0.00
Three	21.89	0.00	0.00	95.97	0.00	0.00	0.00
Four	16.28	0.00	100.00	4.03	100.00	60.87	1.90
Five	33.82	0.00	0.00	0.00	0.00	39.13	98.10

NOTES: RUG-II is resource utilization group, version II. PDG is patient-dependency group.

SOURCE: Duke University, Center for Demographic Studies: tabulated from New York State Medicaid data.

PDGs also relate to mixtures of the GOM types (e.g., severe behavior is associated with the oldest-old types). This is problematic without parameters representing within-group variation in the PDGs.

To describe individual variation in health and functioning, the g_{ik}'s for each type were plotted for each of the 16 RUG-II and 5 PDGs. Figures 1 to 6 contain patterns of association found at the individual level. Results from other graphs are discussed as relevant.

Figure 1 contains the 20 resident patients classified into RUG-II 1 (Special Care, ADL sum = low). The lines represent the g_{ik} scores for these 20 people on the six types. The height of the line reflects the number of residents whose g_{ik}'s fell into a particular range, e.g., 10 observations had scores for Type 6 ("Severely impaired") between 40 percent and 45 percent.

The resident types are defined in GOM using only health and functional status variables. To the extent that either RUGs or PDGs capture the same dimensions, a type will also tend to characterize the RUG or PDG. Because there are more RUGs than types, each type is necessarily present in multiple RUGs. We will be interested, however, to see if resident types are associated with RUGs across multiple RUG domains as opposed to the scaling by impairment of RUGs within the five domains. In Figure 1, for example, the highest g_{ik}'s for RUG-II 1 are found for Type 5 and Type 6. Though both are severely impaired, the two types represent clinically quite different types, with Type 5 having dementia as its characteristic condition and Type 6 being young and terminally ill. It could be expected that, although both types of residents might have high resource needs, the kinds of service each needed could be specialized and their expected clinical course and outcome different. Thus, a comparison of the resident types with the services provided and the resident's outcome could determine if the nursing home was effectively translating the reimbursement into an appropriate set of services. This can be done with the clinically defined types but not with the service-based groups for at least certain major classes of patients.

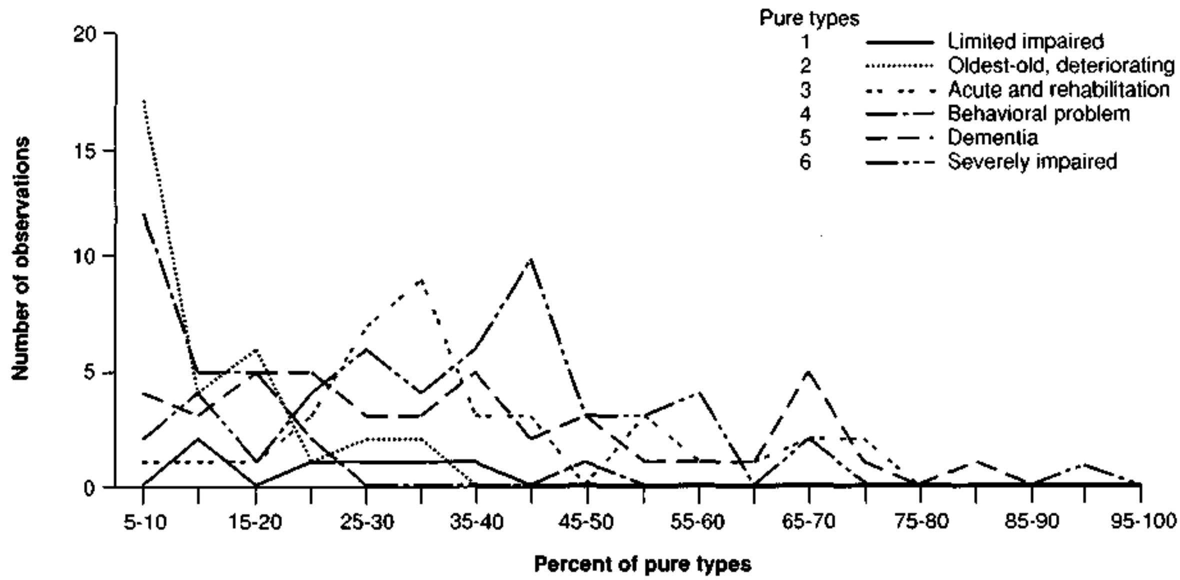
RUG-II 2 (Special Care, ADL sum = high) is strongly characterized by Type 6 ("Severely impaired"). Type 6 is reasonably associated with both RUG-II 1 and 2 because it represents the most physically seriously ill residents. Type 5 residents are also seriously impaired but with dementia and mental deterioration. Thus, the association of Types 5 and 6 is consistent with expectations for RUG-II 2, and RUG-II 1 includes persons that GOM characterizes as suffering from mental deterioration.

RUG-II 3 and 4 (Rehabilitation) are strongly associated with Type 3 ("Acute and rehabilitative") (not shown). Thus, both classifications captured the rehabilitation dimensions fairly efficiently, because persons whose functional and health characteristics indicated a need for rehabilitative services received those services in New York State. In States providing fewer rehabilitation services, this group might not be identified by AUTOGRP.

RUG-II 5, 6, 7, and 8 (graphs not shown) are clinically complex RUGs distinguished by ADL sum. RUG-II 5, with the lowest ADL sum, is associated with Type 1 ("Limited impaired"). The association of Type 3 ("Acute and rehabilitation") with RUG-II 5 reflects its clinical and service definition. RUG-II 6 is related to Types 3 and 5 ("Acute and rehabilitation" and "Dementia"). Type 5 is related to RUG-II 7, but RUG-II 7 and 8 are also related to Type 6, "Severely impaired." The pattern of relation of these RUGs to the GOM dimensions shows that the relation of resident types

Figure 1

Percent distribution of grade of membership pure types for RUG-II 1, by number of observations

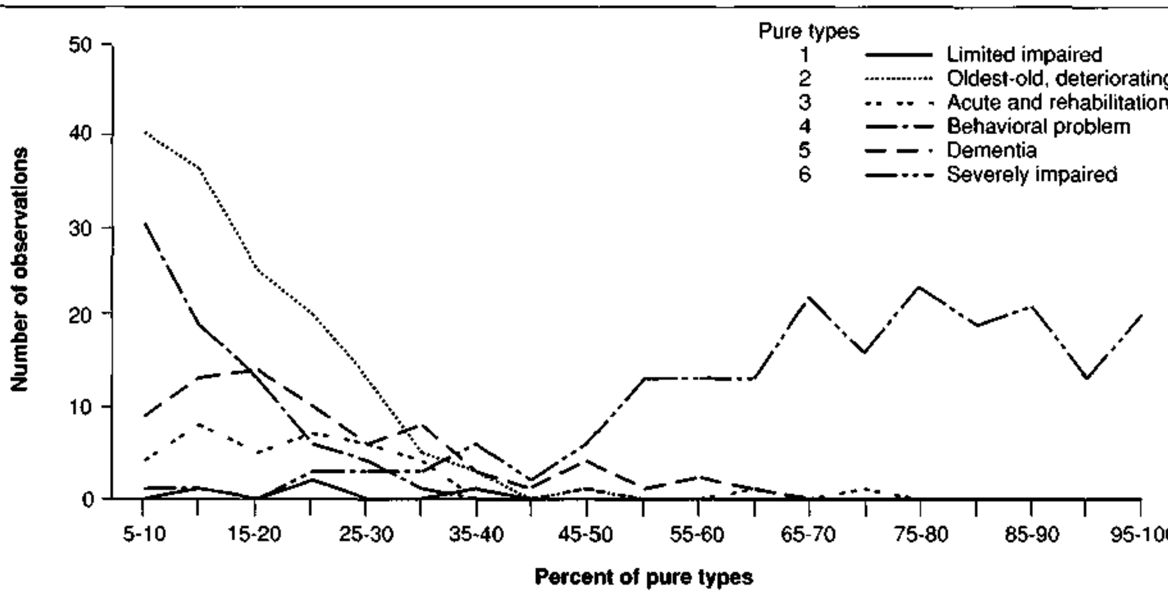


NOTES: RUG-II is resource utilization group, version II. Special care, activity of daily living sum equals low.

SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

Figure 2

Percent distribution of grade of membership pure types for RUG-II 2, by number of observations



NOTES: RUG-II is resource utilization group, version II. Special care, activity of daily living sum equals high.

SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

changes from low ADL to high ADL for the clinically complex RUG-II. Type 1 is associated only with RUG-II 5. Type 3 is blended with Type 1 for RUG-II 5 and with Type 5 for RUG-II 6. Type 6 emerges in RUG-II 7 and is dominant for RUG-II 8. The changes from Type 5 to Type 6 represent movement from a healthy (for a person in a nursing home) to a severely impaired dimension, which parallels the changes in impairment between the clinically complex RUG-II. However, the clinically complex RUGs are also partly associated with the behavioral problem type. This indicates that physical and behavioral problems are often found together for a given person, though this fact cannot be directly represented in the RUG-II categories.

Residents in RUGs-II 9, 10, and 11 have behavioral problems, and Type 4 residents are the behavioral problem type. The pattern of g_{ik} scores on these RUGs is presented in Figures 3-5.

In each case, Type 4 peaks with g_{ik}'s between 10 and 20 percent, indicating that, though persons classified in these RUGs have behavioral problems, they are not strongly characterized by this dimension. Instead, the pattern most resembles that observed for the clinically complex RUGs. Specifically, RUG-II 9 contains high scores for Type 1; RUG-II 10 contains high scores for Type 5; and RUG-II 11 contains high scores for Type 6. Again, the progression from healthy to severely impaired is seen, along with the ability of the GOM types to distinguish between physical and mental deterioration—along with behavioral problems.

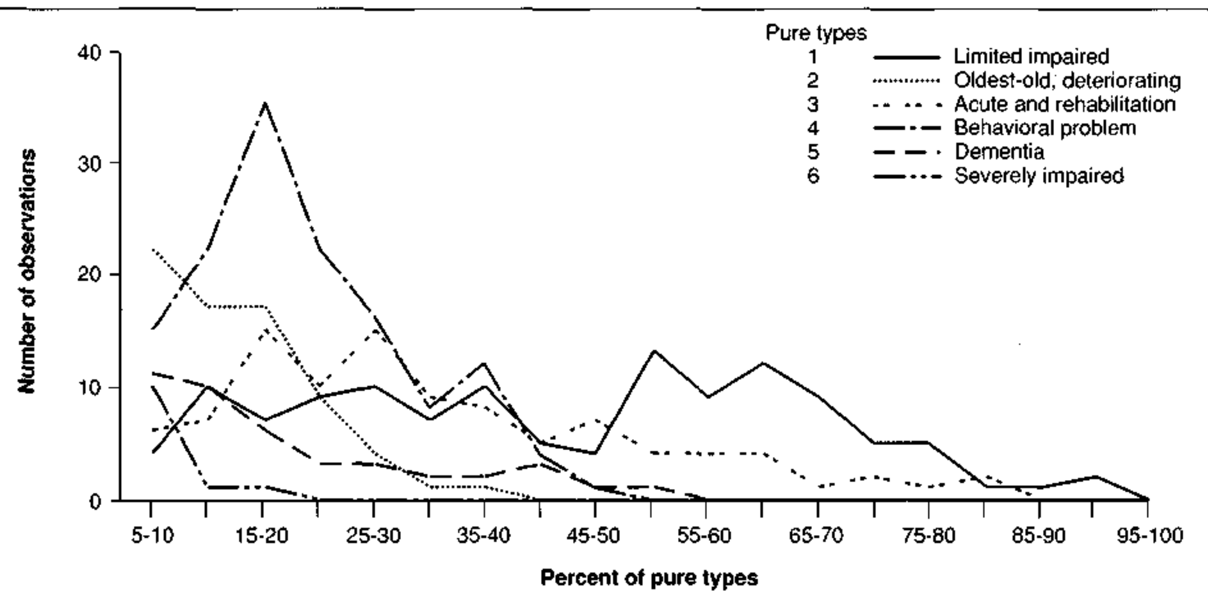
RUG-II 12 to 16 (not shown) are the physical RUGs and represent the lowest levels of resource use. The distinction between these RUGs is made on the number of ADL impairments, organized from low (12) to high (16). Again, a progression in GOM types is observed within this set of RUGs. Type 1 ("Limited impaired") is related to RUG-II 12, with some contribution of Type 3 ("Acute and rehabilitative). Type 3 dominates RUG-II 13, with some contribution of Type 5 ("Dementia"). Type 5 dominates RUG-II 14 blended with Type 3, reversing the pattern for RUG-II 13. Type 6 ("Severely impaired") is related to both RUG-II 15 and 16 though in both cases, it is combined with Type 5.

These results demonstrate strengths and weaknesses in the way the RUG-II case-mix system relates to the multidimensional clinical characteristics of this sample. *RUG-II does not isolate the oldest-old (Type 2) as a* distinct group. Persons characterized by the behavioral problems type are distributed across RUG-II domains with some loading into the "Severe behavior" RUGs, even though this type does not dominate those RUGs. This is probably because persons of this type are categorized into one of the "higher" set of RUGs where specialized services are the identifying variables.

The RUG-II 2 group (Special Care, ADL sum = high) and the "Heavy rehabilitation" RUG-II were most clearly related to the GOM types even though both are defined in the RUG-II system by specialized services. This suggests a good concordance of the provision of these services with the clinical need for services. An area of

Figure 3

Percent distribution of grade of membership pure types for RUG-II 9, by number of observations

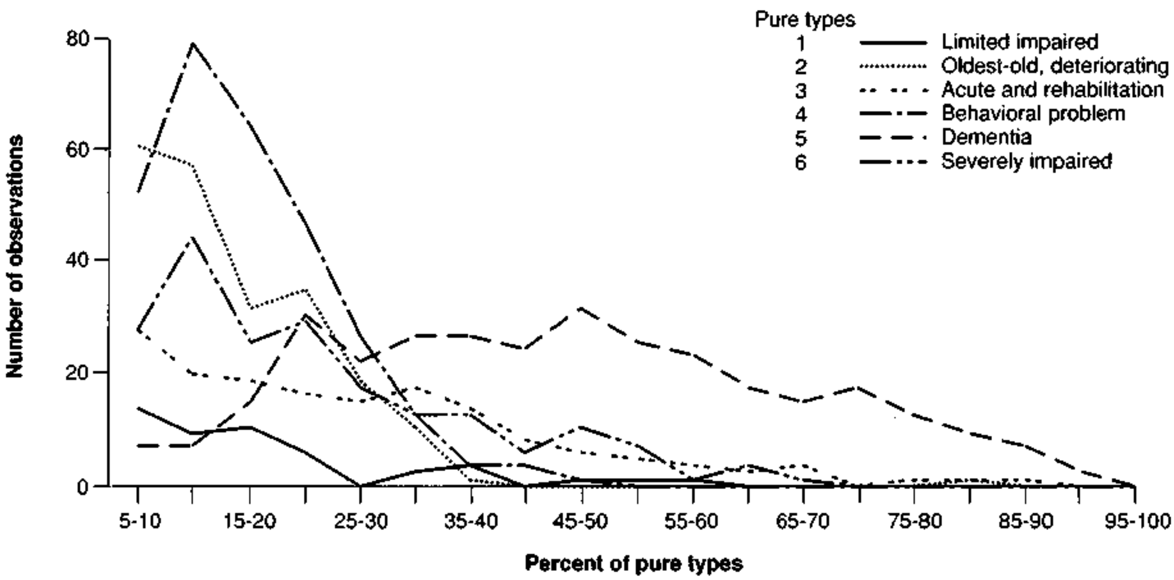


NOTES: RUG-II is resource utilization group, version II. Special care, activity of daily living sum equals high.

SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

Figure 4

Percent distribution of grade of membership pure types for RUG-II 10, by number of observations

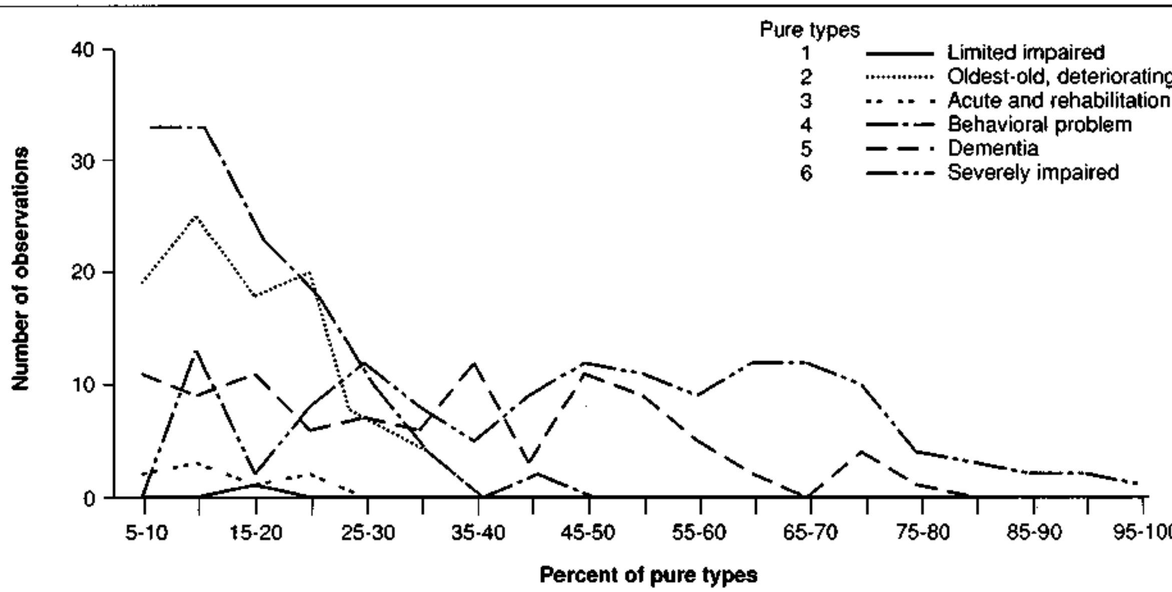


NOTES: RUG-II is resource utilization group, version II. Special care, activity of daily living sum equals high.

SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

Figure 5

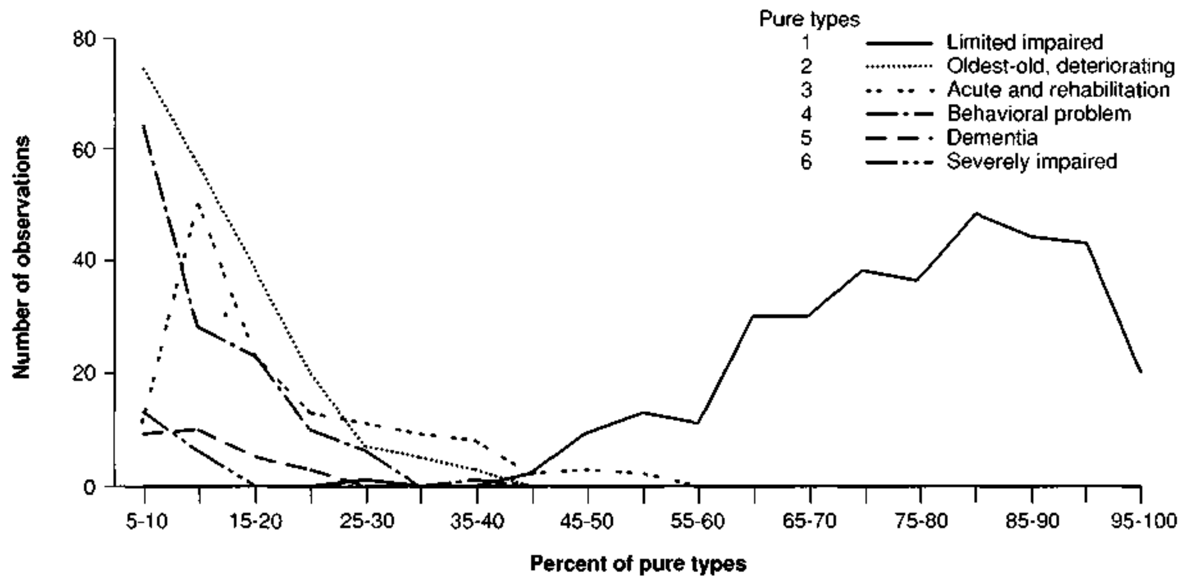
Percent distribution of grade of membership pure types for RUG-II 11, by number of observations



NOTES: RUG-II is resource utilization group, version II. Special care, activity of daily living sum equals high.

SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

Figure 6
Percent distribution of grade of membership pure types for patient-dependency groups, by number of observations



SOURCE: Duke University, Center for Demographic Studies: Figures tabulated from New York State Medicaid Data.

confounding of clinical types with RUG-II is for persons with behavioral problems, a type specifically isolated by GOM. The exception to this confounding, as noted, is the RUG-II 2 group, which describes the same people as Type 6. The remaining sets of RUGs exhibit a common pattern. The low ADL RUGs have a component represented in GOM by Type 1 loading into these RUGs. High ADL count RUGs pick up the dimension identified as severely impaired (Type 6). The remaining RUGs (those between the high and the low points on the ADL score variable) are mixtures of several types.

The PDGs use ADL deficiencies to define groups. The fifth PDG (Figure 6) is the highest resource PDG. Type 6 ("Severely impaired") and, to a lesser extent, Type 5 (Dementia) are related to this PDG.

The fourth PDG, "Dressed entirely by others," is associated with Type 5. Type 3 ("Acute and rehabilitative") characterizes the third PDG ("Help required transferring"), and the second PDG ("Incontinent or help required dressing") is a blend of Types 3 and 1 (healthy). The final PDG is related to Type 1.

These relations define a hierarchy, i.e., the PDGs relate to Types 1, 3, 5, and 6 in descending order. This ranking requires mixing GOM types for two of the PDGs. The PDGs do not strongly reflect the dimensions described by Type 2 ("Oldest-old, deteriorating") and Type 4 (Behavioral problem"). Because PDGs are based only on ADLs, it is not surprising that the behavioral problem type is not identified. The failure of both PDG and the RUG-II systems to uniquely capture the dimension represented by Type 2 (Oldest-old, deteriorating) is serious, given the importance of this group in nursing home populations.

Discussion

The primary purpose of this article was to compare the ideal multivariate clinical dimensions identified by the GOM model with the group assignments made in two classification systems specifically designed for paying for nursing home care. This comparison was done using a common data set.

The GOM model described the medical and functional characteristics of the population found in nursing homes in New York State using six resident types. The six types were associated with 3 of the 16 RUG-II in a way that indicated that the two procedures identified strongly correlated dimensions of treatment and clinical status. The association of the GOM dimensions with the remaining RUG-II, considered as five sets, exhibited some consistent patterns. Within a set of RUGs, the sum of specific ADL deficiencies separates the individual RUGs. This, combined with the use of services for grouping, meant that persons with behavior problems (as described by GOM) were found in most RUGs—not only in RUGs labeled "Severe behavior problem." The RUGs for behavior problems were associated not only with the behavior problem type but also with types related to physical deterioration and functional impairment. The use of specific services to define certain RUGs is important because the RUG hierarchy requires that a patient is assigned to the group with the highest level possible of reimbursement. These decision rules are required for RUG-II because each resident must be assigned exclusively to a single category. The consequence of the hierarchical assignment forced by the discrete grouping, however, is that clinically different resident types may be classified together by the RUG-II system. This happens because these residents received similar services. Though providing higher payments for some cases, it is difficult to evaluate the appropriateness of either services or outcomes under RUG-II because of this hierarchical assignment.

In addition, RUGs did not identify the dimension associated with Type 2 persons, the "Oldest-old, deteriorating." The GOM definition of this type does not rely entirely on ADLs. Instead, these are very old people and people with heart problems, arthritis, pain, problems with vision and hearing, often wheelchair bound. The lack of an oldest-old group to define such complex resident profiles may be an important limitation of the RUG-II system in providing incentives for appropriate care.

The simplicity of the PDG system, though appealing, requires extensive mixing of four of the resident types. The PDGs failed to identify persons with behavior problems. The RUGs failed to adequately describe this population because their classification based on service use confounded the classification based on patient characteristics. The PDGs simply did not use such factors. In addition, like the RUGs, the PDGs did not identify the dimension represented by the GOM type labeled "Oldest-old, deteriorating."

Both RUG-II groups and PDGs are designed to replicate the concepts used in DRGs employed in the PPS (Pettengill and Vertrees, 1980), where fixed payments per discharge provided hospitals with incentives to operate more efficiently with quality assurance being a separate process. PPS assumed that hospital costs were higher than necessary for the efficient provision of high quality care so that providing incentives to contain costs could be done without compromising quality. The RUG-II and PDG case-mix systems attempt to implement a similar set of incentives by defining groups of nursing home patients so that each group contains residents for whom nursing homes are currently providing similar levels of care. When nursing homes are paid for this amount of care, it is assumed that this care is provided. Quality of care assurance in these systems is also a separate process.

The problems for Medicaid programs in developing payment systems for nursing home care are different from those for hospitals. Medicaid programs are effective in controlling nursing home payment. Because of this, case-mix-based payment is advocated to pay more for nursing home residents who need specific kinds of unusually heavy care and to pay less for other patients. This is to guarantee access for heavy-care patients and to increase the equity of the flat per diem payments often used by Medicaid programs. Unfortunately, the current pattern of care provided in nursing homes does not necessarily reflect the provision of necessary care to some residents with high levels of need. Assuring that Medicaid beneficiaries actually receive the level and quality of care that the program is paying for is, arguably, the most important long-term problem facing Medicaid programs, i.e., quality assurance, not cost containment, is the fundamental problem.

The development of a case-mix system that provides direct incentives for quality of care requires a fundamentally different set of incentives from those based on a PPS model, where incentives are primarily for efficiency. Such a quality-based incentive system would be complex and difficult to implement. However, consideration of what such a system might contain is useful for the insights it may provide into modifying the current systems. The initial stage in developing such a system is to define what is meant by quality of care in a nursing home setting. Quality care in nursing homes could be defined as care that restores functional abilities or minimizes their loss and discharges people to noninstitutional care settings to the maximum extent appropriate. Assuring that quality care is provided means that the process of recovery and decline needs to be measured. In addition, a quality assurance process operates most efficiently if measurement of the processes of recovery and decline is based on information that nursing homes must provide the payer (the Medicaid program). It is desirable, if homes have fiscal incentives, to provide accurate information.

It is difficult to represent the processes of recovery and decline in discrete categories. In contrast, a multidimensional procedure like GOM can easily be used to measure the processes of recovery and decline by measuring the changes in the g_{ik} scores for residents over time. Given this, GOM could be used to define case-mix systems to allocate reimbursements to maximize the quality of care as defined by the outcomes of that care. Indeed, the GOM scores ($g_{ik}s$) are a direct and continuous representation of changes in the health and functional status of patients (outcomes). Thus, these scores could be used to scale reimbursements for differences in these outcomes though blending of GOM types and rates for a particular patient might be difficult for nursing homes to handle administratively. In addition, GOM types do not reflect the current, potentially non-optimal patterns of service use. Thus, the definition of GOM types is not distorted by current resource use patterns.

If one were to base a nursing home payment system on the outcome-based quality assurance process previously described (comparing the expected rate of recovery and decline with the actual performance of the home) and then used the same information to adjust payments to the home as was used to develop those expectations, the nursing home operator would face a useful dilemma. Revenues are increased by reporting that residents have declined, but this increases the likelihood that the home will be identified for problems with quality of care. The operator can avoid being identified as having quality problems by reporting that patients have improved (or not changed), but this lowers revenue for the home. The nursing home can escape the dilemma only by providing high quality care and by reporting changes in patient condition accurately.

Though it is potentially burdensome, this approach gives providers incentives to provide quality care by using GOM to measure the processes of recovery and decline and to scale reimbursements to those changes.

These changes can be compared with the expected rate of change for the industry as a whole. Homes where decline is more rapid or rehabilitation slower than expected would be targeted for review and possible action. This would be done irrespective of inputs to and the process of care. Because quality is defined in terms of outcomes, payers focus on "what works." The data accuracy needed to support this process is enforced by adjusting payments for changes in case mix. Providers receive higher or lower payments by providing the information used in the targeting process. The link between quality assurance and case-mix payment is the use of the same information for both processes.

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