A RUG-III Case-Mix System for Home Care*

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RÉSUMÉ

Le système de classification de la composition de la clientèle des maisons de soins infirmiers, Resource Utilization Groups Version III (RUG-III), a été éprouvé et raffiné pour les bénéficiaires de soins de longue durée à domicile. L'échantillonnage étudié regroupe 804 personnes recevant des soins à domicile par l'entremise du Michigan Care Management Program ou du Home and Community Based Waiver for the Elderly and Disabled. On a catégorisé les clients et établi des modèles de RUG-III à partir du Minimum Data Set for Home Care (MDS-HC). On a établi un modèle raffiné de soins à domicile, RUG-III/HC, en incorporant les activités instrumentales de la vie quotidienne (AIVQ) à la classification RUG-III des établissements de soins. Le modèle explique 33,7 pour cent de la variance des coûts quotidiens, à partir de la variable dépendante du coût pondéré des soins structurés ou non. L'utilisation des ressources à l'égard des différents groupes est relativement homogène. Le CMI (case-mix index) du temps pondéré des soins structurés ou non couvre une échelle de 8. Il faudra songer à effectuer des analyses plus poussées du coût de l'inclusion des soins non structurés à l'égard des patients recevant des soins à domicile de longue durée.

ABSTRACT

The nursing home case-mix classification system, Resource Utilization Groups Version III (RUG-III), has been tested and refined for long-term home care clients. The study sample included 804 individuals seeking home care through the Michigan Care Management Program or the Home and Community Based Waiver for the Elderly and Disabled. Clients were classified, and RUG-III models were derived using the Minimum Data Set for Home Care (MDS-HC). A refined home care model, RUG-III/HC, was developed incorporating Instrumental Activities of Daily Living (IADLs) to the nursing home RUG-III classification. The model explained 33.7 per cent of the variance of per diem cost, using cost weighted formal and informal care as the dependent variable. Resource use within groups was relatively homogeneous. The case-mix index (CMI) of weighted formal and informal care time spanned an eight-fold range. Further analysis is suggested regarding the inclusion of informal care as a cost in case-mix classification for long-term home care clients.

Introduction

Case-mix measures have been successfully developed in institutional health care settings. Such measures provide the core methodology for developing prospective payment systems, key measures for management, and important descriptors for understanding cost and quality of care. Case-mix is by definition a system that explains resource use. Most current systems classify patients into groups that are homogeneous in their consumption of resources and cost. A good case-mix system also gives meaningful clinical descriptions of patients. The application of case mix is broad, it provides the basis, not only for reimbursement, but also for comparing facilities or programs, as an adjunct to quality of care measurement, for comparing facility/program management, efficiency, practice patterns, etc.

While successful case-mix systems have been developed for hospitals (1), and for nursing homes (2), development of case-mix systems in home care has proven to be more difficult. In home care, determinants of service needs are complex, involving several dimensions of functional disability and medical conditions, but are also highly dependent upon the agency, independent of client characteristics (3). In addition, resource consumption, the dependent variable, is difficult to determine in home care given large contributions from informal caregivers. Still there is considerable interest in developing a viable home care case-mix system, as home care in the last ten years has been a rapidly growing segment of health care, a trend shared by many countries.

In the United States, researchers have developed a variety of case-mix classifications for home care (3, 4, 5, 6, 7, 8, 9, 10, 11). However, a majority of these studies have been limited either in their accuracy in measuring the dependent variable, or in the selection and availability of independent variables. Thus, there have been in place for over a decade systems that adjust payment to institutions for case-mix, yet such systems for home care

have not been implemented. The primary cause is the lack of a home care case-mix adjustment system that explains a significant amount of variation in cost, and would be appropriate for payment.

A key factor in developing case-mix systems is whether they should explain episode cost or per diem cost. In acute care hospitals, the cost episode approach of the Diagnosis-Related Groups (DRGs) has been found both feasible and effective for prospective payment (1). In contrast, the variability of length of stay (and thereby episode cost) in long-term care is too great to be practical for case-mix classification and payment. As a result the most prevalent system, Resource Utilization Groups (RUG), classifies nursing home residents based on per diem resource use. The newest version, RUG-III (2), is incorporated into the U.S. Medicare Prospective Payment System and the Medicaid systems of approximately one third of U.S. states. Recently, the government of Ontario announced that RUG-III will be used to fund chronic care hospitals in that province (12).

For home care there has been no consensus on whether case-mix systems should be developed based on episode cost or per diem cost. Previous research suggests that both approaches may be necessary. The home care population clearly comprises both clients with short-term care needs and those with chronic disabilities and long-term needs. In the U.S. the trend in recent years has been toward the provision of more long-term home care. For example, in the Medicare system there has been a considerable increase in the proportion of clients receiving home care for more than six months (13, 14). In state Medicaid systems, there are currently over 226 home and community based waiver programs, serving more than 250,000 people as alternatives for long-term institutional care (15). The RUG classification may therefore be a plausible approach for developing a case-mix system for home care, at least for the frailest group of home care clients.

This article explores the possibilities of applying a modification of the nursing home RUG-III system to a long-term home care population. Our emphasis is on validation, i.e. to fit a RUG-type system for application, rather than derive a case-mix system de novo. While the validated system might not be the single best system in the home care environment the use of a congruent system in both nursing homes and home care would have significant benefits for integrating these settings and understanding transitions of patients between them. Thus, we both test a RUG-III system fitted to the home care sector and develop a refined RUG-III model incorporating classification items especially relevant for home care clients. The source of variables for these systems has also been integrated. In nursing homes RUG-III is based on information in the Resident Assessment Instrument (RAI), the Minimum Data Set (MDS). The RAI is a standardized, multidimensional assessment instrument, implemented nationwide in the U.S. since 1990 to improve care planning and quality control in nursing homes (16). Its reliability and validity have been shown

in multiple studies (17, 18, 19, 20, 21, 22, 23, 24). A corresponding home care assessment system, the RAI for Home Care (RAI-HC) (and its Minimum Data Set, the MDS-HC) has more recently been developed by inter-RAI, an international consortium of researchers and clinicians (25). The RAI and RAI-HC have many assessment items in common, including measures of physical and cognitive function, continence, mood, etc. The reliability of items common to both instruments is correspondingly high in each setting (21). In this study, we validate the RUG-III for home care using the MDS-HC. Both assessment instruments, the RAI for nursing homes and the RAI-HC are currently used in several U.S. states, and are being considered for mandatory use in several Canadian provinces (12).

Resource Utilization Groups – Version III (RUG-III)
RUG-III was developed based on a sample of 7,658 residents of 203 nursing homes in seven U.S. states, and most recently validated for the latest version of the MDS (Version 2.0) on an additional sample of over 2,000 residents. A resident is classified into one of 44 distinct groups. RUG-III achieves over 55 per cent variance explanation of total (nursing and therapy) per diem cost, and the mean resource use (case-mix index) of groups spans a nine-fold range (2). RUG classifications have also shown to be valid across nations and health care systems (26, 27, 28, 29, 30, 31, 32).

RUG-III incorporates three dimensions in describing and classifying a resident. The first dimension includes seven major types of nursing home residents: Special Rehabilitation, Extensive Services, Special Care, Clinically Complex, Impaired Cognition, Behaviour Problems, and Reduced Physical Functions. The clinical categories are ranked hierarchically, in decreasing order of resource use. Once a major clinical category is assigned, a resident is classified into a subcategory usually based on an index of four Activities of Daily Living (ADLs) (toileting, eating, transfer, and bed mobility). The final dimension and split incorporates particular services (nursing rehabilitation) or problems (depression) (2).

A majority of the items defining RUG-III are available in the MDS-HC in exactly the same form as in the nursing home MDS Version 2.0. In addition, the MDS-HC provides a broad range of other characteristics that are especially relevant for home care clients. Of particular interest are seven measures of Instrumental Activities of Daily Living (IADLs), describing higher level integrative functioning, such as shopping, managing medications, and meal preparation. Altogether, the MDS-HC covers nearly 300 individual items in describing strengths and needs of home care clients. The MDS-HC also includes assessed measures of formal and informal care time, which can be used as proxies for resource use and cost.

Methods

Study Sample
The RUG-III classification was tested on a sample of individuals seeking home care through the Michigan Care Management Program or Medicaid Home and Community-Based Services Waiver for the Elderly and Disabled. These data were collected between November 1996 and October 1997 to develop a screening system for the Waiver Program. At the time of data collection, the Care Management and Waiver programs served individuals in 14 regions across the state through the Area Agencies on Aging (AAA). Eligibility for these programs is granted to those who, without home care, would likely go into a nursing home soon, if not immediately.

The sample used for this study included 804 community-based individuals. These were drawn from a slightly larger sample from which we excluded 91 individuals who were either in the nursing home or in the hospital at the time of the initial assessment, as their resource use would not be representative of home care users. The sample comprised a majority of the clients served by these home care programs in the 14 AAAs. The clients were selected randomly in the sense that every or every other client that called in was asked to participate in the study. We do not have information on those who refused to participate, although the number of refusals was small. The clients were assessed at "intake" and at 45, 90, and 180 days after intake, so long as clients remained in one of the home care programs. Thus, the care time collected represents all types of care, including any terminal care. Because the number of clients assessed at each follow-up declines due to death, discharge and loss to follow-up, the primary analysis here is based on the 804 initial assessments. Subsequent analyses employ the follow-up assessments.

Resource Use
The dependent variable used in the analysis represents both formal and informal care time. The MDS-HC records assessors' estimates of the weekly intensity of care time (25). These estimates cover virtually all care services provided in the home, not only those given through the home care programs. Formal care time is the time spent by formal caregivers, and includes home health aides, visiting nurses, homemaking services, and a social worker in the home. Formal rehabilitation includes the time spent by physical, occupational, and speech therapists. Informal care time reflects the total amount of unpaid care provided by family members, friends, and neighbours (both primary and secondary caregivers). It is the time spent assisting the client in instrumental and personal activities of daily living as well as providing emotional support. The measures of formal and informal care time are self-reported. For example, the assessor completing the MDS-HC asked the primary or/and secondary caregiver how much time they spent caring for the client in the previous seven days.

To develop a univariate cost measure, formal care time was weighted by cost, using wage rates of respective staff categories. The wage rates were derived from a survey of home care agencies in Michigan (33), and one of the targeted home health agencies. As most formal care is reimbursed on a per-visit rate, and hourly wages were not available for every formal caregiver category, the relative wage weights represent crude approximations of hourly cost. The rates used are provided in Table 1, after standardization by setting the rate for home health aides to 1.0. Post-hoc experiments showed that our results are not sensitive to small variations in these rates.

In evaluating home care case mix, consideration of informal care is a critical issue, as it often substitutes directly for formal care. However, we were unwilling to assume an hour-for-hour trade-off. A priori, we selected to weight informal care time by 0.50, half of that for home health aides (and less than that for homemaker services). We employed sensitivity analysis to test the effects of using different weight levels for informal care time. The variance explanation improved slightly as informal care time was weighted less, although the proportional differences between group means (of staff time) did not change greatly. Rather than choose the value to maximize variance explanation, we selected it from within a reasonable range compared to similar support given by formal caregivers.

RUG-III Models

Our first step was to model the nursing home RUG-III system using only variables available in the MDS-HC. As shown in Figure 1, a majority of the items needed to classify a client into one of seven clinical categories can be found in the MDS-HC. The ADL Index, which functions as the second split in RUG-III, is based on both ADL self-performance and ADL support provided. The Index ranges from 4 to 18 (2). The MDS-HC does not include assessment of ADL support, but has all 4 ADL self- performance measures. As a result, our home care ADL index ranges from 4 to 15. This structurally excludes several RUG-III groups that require ADL scores of more than 15. We also did not have in the MDS-HC measures of nursing rehabilitation, and only limited measures indicating depression, thereby excluding these tertiary splits defining RUG-III groups.

The availability of data items thus led to three a priori changes to the RUG-III system for use with the MDS-HC: a) a decreased ADL-index range, b) the exclusion of tertiary splits by nursing rehabilitation, and c) the exclusion of tertiary splits by depression. In addition, given the small numbers of home care clients receiving heavy rehabilitation, we decided to collapse the large number of rehabilitation groups. We used information from another RUG-based study for classifying clients into only two rehabilitation groups (3). Clients were classified into a Special Rehabilitation category if they received 120 minutes or more per week of physical, occupational or speech therapy. The final two groups were defined based

Special Rehabilitation
  Minutes of rehabilitation therapy
    (Physical, Occupational, and Speech)
  Days of rehabilitation therapy
    (Physical, Occupational, and Speech)
  [Types of nursing rehabilitation]

Extensive Services
  Parenteral feeding
  Suctioning
  Tracheostomy
  Ventilator/respirator

Special care
  Burns
  [Coma]
  Fever (with vomiting, weight loss,
    pneumonia, or dehydration)
  Multiple Sclerosis
  Pressure ulcers (stage 3 or 4)
  Quadriplegia
  Septicemia
  IV medications
  Radiation treatment
  Tube feeding

Clinically Complex
  Aphasia
  [Aspirations]
  Cerebral palsy
  Dehydration
  Hemiplegia
  [Internal bleeding]
  Pneumonia
  Stasis ulcer
  Terminal illness
  Urinary tract infection
  Chemotherapy
  Transfusions
  [Wound care other than pressure ulcer care]
  Active foot care dressings

Impaired Cognition[2]
  [Coma]
  Short-term memory
  Decision-making
  Make self understood
  Eating performance

Behaviour Problems
  Inappropriate behaviour
  Physical abuse
  Verbal abuse
  Wandering
  Hallucinations

Reduced Physical Functions
  All remaining patients

[1] Items in brackets [ ] indicate RUG-III variables not available in the MDS-HC
[2] Group definitions for Impaired Cognition are based on the Cognitive Performance Scale
(19).

Figure 1 Definitions for main clinical categories in RUG-III[1]

on the ADL index. The basic RUG-III system we tested, including all of these modifications, is presented in Figure 2.

The second step was to test the effect of augmenting our "fitted" RUG-III system using factors known to predict resource use in home care. Given the greater functional capability of many home care clients, we expected that the most ADL-independent groups might beneficially be split based on IADL measures. We limited our analysis of additional explanatory variables to the IADLs only; the derivation of the related tertiary split will be described in the following sections.

Analytic Methods
We tested the RUG-III models using traditional measures of statistical fit: variance explanation (R^2), coefficient of variation (CV) and significant differences between groups. For the main part of the analysis, including
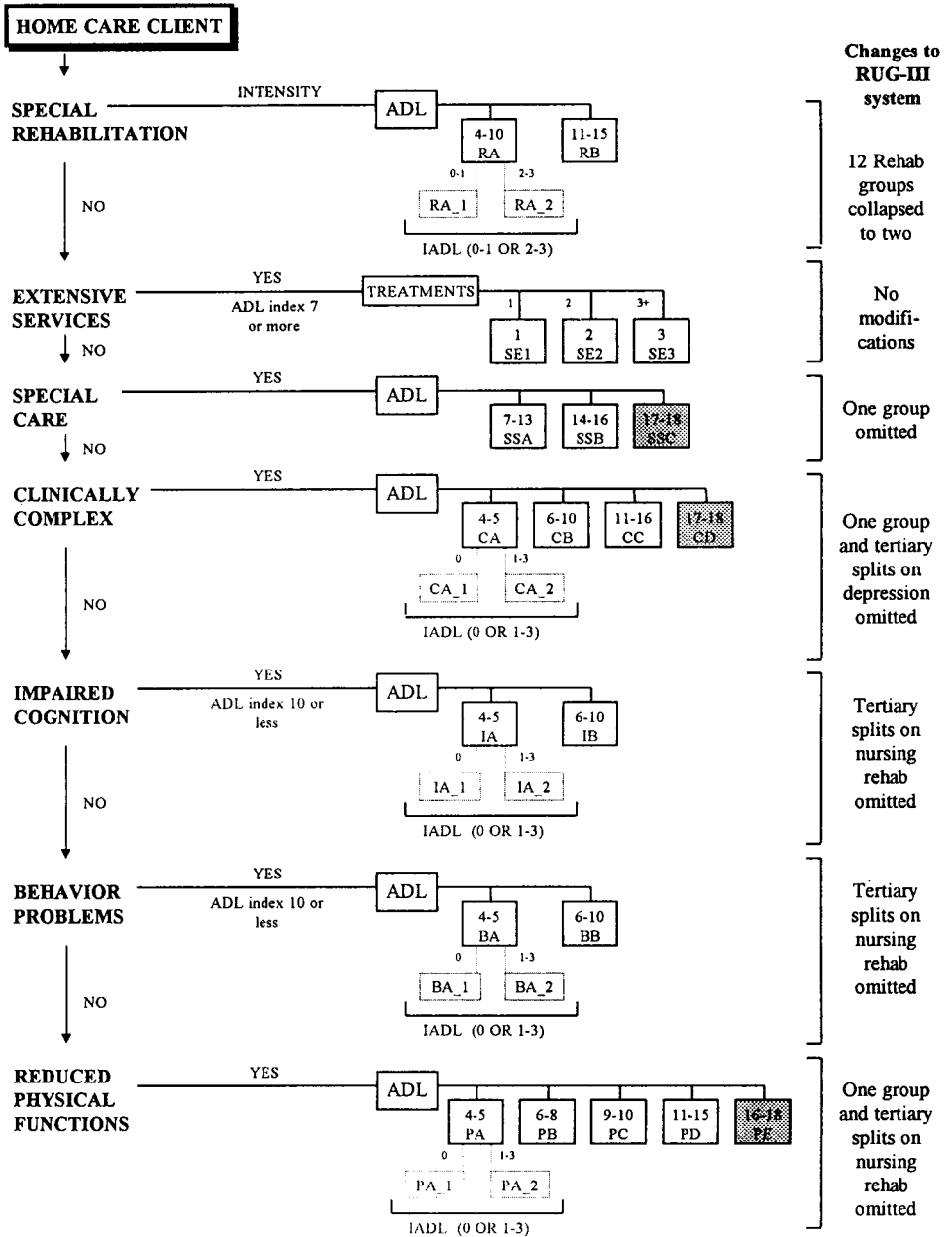
Notes: Not all of the RUG-III system is shown: right column indicates groups omitted. Shaded groups are omitted because ADL index > 15. (For complete description of RUG-III see (2)). New groups for RUG-III/HC shown by dotted boxes.

Figure 2 RUG-III/HC Home care classification

Table 1
Client-specific formal and informal care time and cost weights

Staff Category	Mean client-specific time per week, in minutes per 7 days	Cost weights
Formal Caregiver		
Home health aides	84.7	1.00[1]
Visiting nurses	49.3	1.81
Homemaking services	64.8	0.76
Social worker in home	15.5	2.76
Physical therapy	17.5	3.10
Occupational therapy	7.0	3.10
Speech therapy	2.4	3.10
Total	241.2	
Informal Caregiver		
Family, Friends and Neighbours	1,820.8[2]	0.50[3]

[1] normalized to set this value to 1.0.
[2] 30 hours, 21 minutes
[3] estimated, see text for explanation
N = 804 clients

tests for agency effect, age, and gender, we used an Analysis of Variance (ANOVA) with RUG-III groups, as well as agency, age group, and gender represented by dummy variables. Analysis was performed using SAS 6.12 (34). To construct additional groups based on IADLs, we used PC-Group (35), an interactive software implementation of Automatic Interactions Detection (AID) (36). AID is a statistical clustering technique that partitions observations based on the values of a chosen independent variable (here IADLs) so as to maximize the prediction of the dependent variable. PC-Group was initially employed to construct the RUG-III classification, and a similar earlier implementation of AID was used in the derivation of DRGs (37).

Results

The mean unweighted care time per client during a seven-day period is shown in Table 1. Mean formal care time was 4 hours 16 minutes per week. The corresponding mean of informal care time was 30 hours 21 minutes. Thus, formal care time accounted for about 12 per cent of total time. After wage-weighting, formal care time accounted for 28 per cent of total cost. Out of 804 clients, 46 (5.7%) received no care time (formal or informal). Clients with no care time were found in each of the 14 participating regions in the state. Because the analysis employed baseline data, formal care services may not have been put in place for all clients at the time of the initial assessment. This could explain the zero values for formal care time, but it is also possible that there were errors in reporting of care time, or

Table 2
Frequency (N), Case-Mix Index (CMI), Coefficient of Variation (CV), and RUG-III/HC Groups

RUG-III/HC Group Name	Group Code	ADL Range	IADL Range	N	CMI formal care	CMI formal+ informal care	CV formal+ informal care
Special Rehabilitation							
REHAB 11-15	RB	11-15		74	*3.36*	*1.80*	*0.63*
REHAB 4-10I	RA_2	4-10	2-3	18	4.14	2.70	0.39
REHAB 4-10	RA_1	4-10	0-1	23	2.73	2.01	0.60
				33	3.37	1.15	0.55
Extensive Services							
EXTENSIVE 1	SE1	7-15		10	*2.24*	*1.86*	*1.28*
				10	2.24	1.86	1.28
Special Care							
SPECIAL 14-15	SSB	14-15		22	*1.11*	*1.41*	*0.60*
SPECIAL 7-13	SSA	7-13		4	1.59	1.55	0.10
				18	1.00	1.37	0.68
Clinically Complex							
COMPLEX 11-15	CC	11-15		221	*0.66*	*0.85*	*1.15*
COMPLEX 6-10	CB	6-10		15	0.99	2.60	0.45
COMPLEX 4-5I	CA_2	4-5	1-3	31	0.56	1.17	0.97
COMPLEX 4-5	CA_1	4-5	0	87	0.83	0.94	0.94
				88	0.48	0.34	1.02
Impaired Cognition							
IMPAIRED 6-10	IB	6-10		63	*0.62*	*1.56*	*0.72*
IMPAIRED 4-5I	IA_2	4-5	1-3	29	0.33	1.76	0.68
IMPAIRED 4-5	IA_1	4-5	0	33	0.87	1.43	0.72
				1	0.39	0.23	–

Table 2 contd.

RUG-III/HC Group Name	Group Code	ADL Range	IADL Range	N	CMI formal care	CMI formal+ informal care	CV formal+ informal care
Behaviour Problems				*16*	*0.82*	*1.05*	*1.01*
BEHAVIOUR 6-10	BB	6-10		5	2.04	1.51	0.78
BEHAVIOUR 4-5I	BA_2	4-5	1-3	8	0.32	1.05	1.06
BEHAVIOUR 4-5	BA_1	4-5	0	3	0.15	0.31	1.20
Reduced Physical Functions				*398*	*0.78*	*0.80*	*1.22*
PHYSICAL 11-15	PD	11-15		41	1.58	2.04	0.74
PHYSICAL 9-10	PC	9-10		19	1.36	1.41	0.67
PHYSICAL 6-8	PB	6-8		30	1.01	1.07	0.69
PHYSICAL 4-5I	PA_2	4-5	1-3	122	0.77	0.91	1.06
PHYSICAL 4-5	PA_1	4-5	0	186	0.51	0.35	1.25
All				804	1.00	1.00	1.08

Table 3
Variance explanations of Basic RUG-III and RUG-III/HC Case-Mix Systems

	R-square
Initial assesment (N = 804)	
Basic RUG-III	28.2
Basic RUG-III + agency	31.1
RUG-III/HC	33.7
RUG-III/HC + agency	36.7
45-day (N = 639)	
Basic RUG-III	32.6
RUG-III/HC	38.1
90-day (N = 557)	
Basic RUG-III	37.9
RUG-III/HC	42.5
180-day (N = 487)	
Basic RUG-III	38.9
RUG-III/HC	43.5

that these are clients who simply did not need services. In addition, we found clients with extremely high care time. Three clients (1 in group PA_2, 1 in PD, and 1 in SE1) were clearly outliers. The exclusion of these clients improved the fit of the models, increasing the variance explanation by approximately 1.5 per cent. Despite this, in the results presented here we decided not to exclude outliers from the sample.

The distribution of clients into RUG-III clinical categories and final groups are shown in Table 2. (The percentage of clients in each of the main clinical categories was, by construction the same for both of the RUG-III models derived). The two categories with the largest proportions of clients were Reduced Physical Functions (398, or 49.5%) and Clinically Complex (221, or 27.5%). Similar patterns have been seen among nursing home resident populations (2). Special Rehabilitation accounted for 9.2 per cent of the clients. No clients were classified into the third group of Special Care (SSC). Only one person was grouped into each of SE2 and SE3, and these were merged into SE1 for the remaining parts of the analyses.

Basic RUG-III Model
In the basic RUG-III model, clients were classified into 17 of 19 possible groups. After collapsing SE2 and SE3 into SE1, the final system of 16 groups explained 28.2 per cent of the variance of wage-weighted (formal and informal) care time (Table 3). The variance explanation of weighted care time was slightly higher than for unweighted time. When agency identifiers were added to the model the variance explanation increased from 28.2 to 31.1 per cent. The case-mix indices (CMIs), which describe the

relative cost of different RUG groups, were calculated by dividing the group's average by the overall average dependent variable. Overall, the case-mix index for the basic RUG-III model spanned a five-fold range, from Rehabilitation B, the high end, to Physical A (not shown). The CMIs within a clinical group followed expected patterns, increasing with higher ADL dependency. The homogeneity of resource use within groups was measured by the coefficient of variation (CV). The CV for the whole sample was 1.08, which indicated a large variation of resource use between all clients. Four groups (SE1, CA, BA, PA) had a CV higher than that for the whole sample.[1]

RUG-III/HC Model
In the refined home care model, all seven IADLs available in the MDS-HC were considered as variables for possible tertiary splits: meal preparation, ordinary house work, managing finance, managing medications, phone use, shopping, and transportation. The MDS-HC separates for each IADL an evaluation of self-performance and difficulty (how difficult it is, or would be, for a client to do activity on his/her own) which results in a total of 14 variables for consideration of tertiary splits. Using PC-Group, each of the 14 IADL variables was tested for subdividing the basic RUG-III groups. Analysis supported splits only in the groups with the lowest ADL dependency: CA, IA, BA, and PA. In general, the IADL performance variables performed better than the difficulty variables in explaining the variance of weighted (formal and informal) care time. We therefore restricted our attention to the IADL performance variables. In addition, only three IADLs were effective in improving variance explanation: meal preparation, managing medications, and phone use. For efficiency, we combined these three IADLs and used PC-Group to determine the optimal split based on the resulting index. Analyses supported a dichotomous approach in developing the IADL index, with a client considered dependent in an IADL if the activity was performed with full help or only by others. Each client therefore had from 0 to 3 IADL dependencies, our IADL index. Analysis with PC-Group suggested a split based on this index into two or more groups. For consistency we decided to force the tertiary split into two groups only. Use of the IADL index added a total of five groups, splitting the RA, CA, IA, BA, and PA groups (see Table 2). Thus, clients in our derived RUG-III/HC system were distributed into a total of 21 groups. The variance explanation for the RUG-III/HC system was 33.7 per cent, an increase in the variance explanation by 5.5 per cent compared to the basic RUG-III model (28.2%). Forcing the tertiary split into two groups instead of more as suggested by PC-Group lowered the variance explanation by 1 per cent. As in the first model, adding agency identifiers as covariates increased the variance explanation only moderately (from 33.7% to 36.7%). When we tested the RUG-III/HC system across different assessment periods (baseline, 45-day, 90-day, and 180-day) the variance explanation increased monotonically (Table 3). For example, examining the 180-day assessments, the model explained 43.5 per cent of the variance; the total

Figure 3 Case-Mix Index of RUG-III/HC
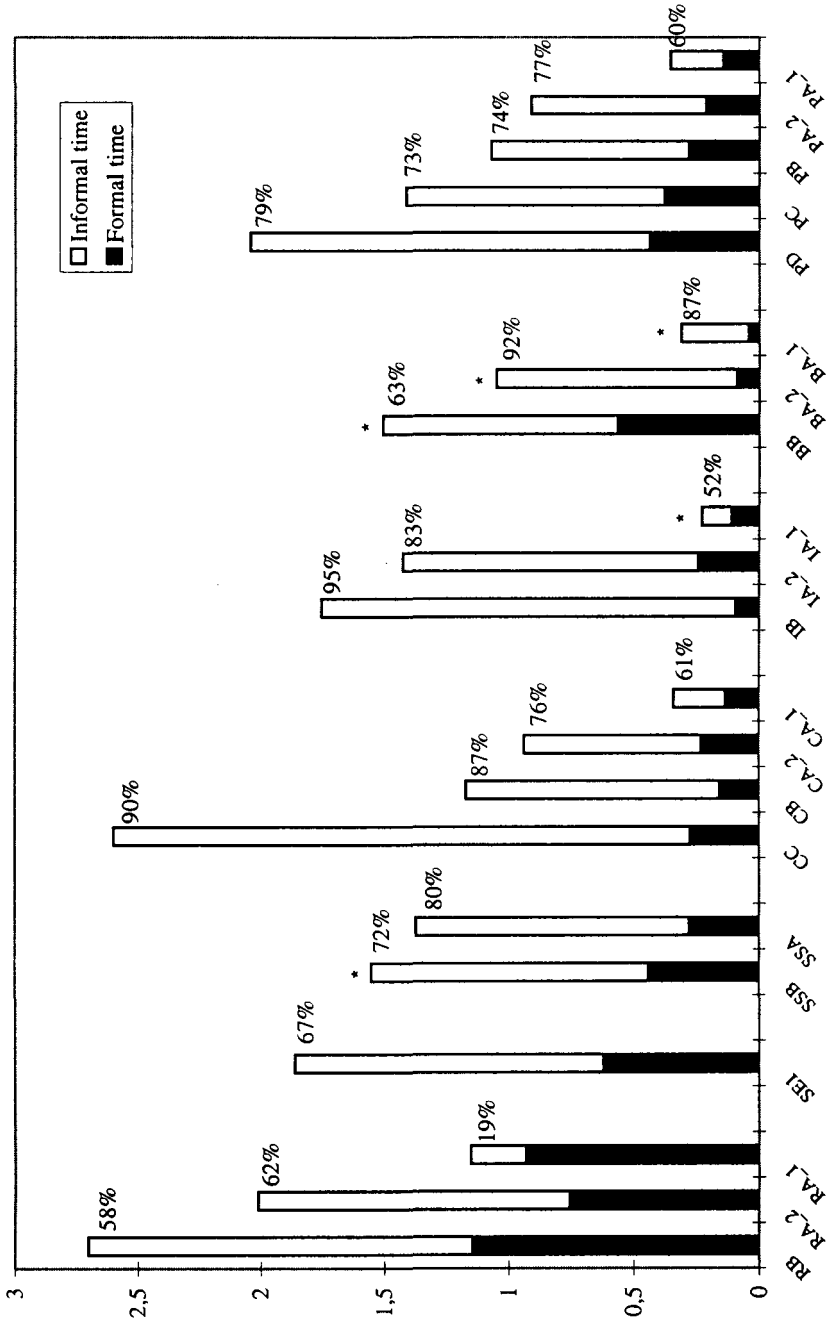
NOTES: The percentage indicates proportion of informal care.
* Less than 10 clients.

number of observations had decreased from 804 at the baseline to 487 at 180 days post-baseline. Socio-demographic variables, such as gender and age, were not statistically significant when added to the model. A dummy variable was created to indicate whether a client lived alone or not, and proved significant ($p < .001$) in explaining cost: clients living alone received about 35 per cent less total weighted care time. However, the inclusion of this variable in the model did not greatly affect the relative differences in the mean care time of the groups (i.e. the case-mix indices of RUG-III/HC).

Figure 3, represents a histogram of the RUG-III/HC case-mix indices (CMIs), indicating the proportions of weighted formal and informal care time. Formal care alone does not capture the intensiveness of resource use between groups. With the exception of the Special Rehabilitation and Extensive Services categories, formal care cost was distributed relatively more evenly across groups than informal care or total cost. The variance explanation of RUG-III/HC using only formal care time was 26.3%. However, when we excluded the Special Rehabilitation groups, a category into which residents are classified based on the provision of rehabilitation services, the variance explanation of formal care time dropped to 7.0%. The corresponding variance explanation of total formal and informal weighted time (excluding rehabilitation groups) dropped from 33.7% to 29.7%. Thus, when both formal and informal care time were included in the dependent variable the exclusion of Special Rehabilitation groups did not affect the variance explanation.

The numeric values of the CMIs for the RUG-III/HC model are presented in Table 3. Groups formed by tertiary splits in the Impaired Cognition and Behaviour Problems categories had low cell sizes, potentially providing unstable estimates of CMIs. This pertains, in particular to the IA_1 group (with only 1 client), and all three Behaviour Problems groups (with less than 10 clients each). Disregarding these groups, the range of CMIs in the RUG-III/HC model was an 8 to 1 range, up from 5 to 1 for the basic RUG-III model. The homogeneity of groups also improved in the RUG-III/HC model. Three groups had higher coefficients of variation than the whole sample. Two of these (SE1 and BA_1) had only a few clients. The most numerous and second lowest care group, PA_1, was the least homogeneous, a phenomenon seen in many other case-mix studies.

Discussion

This study is a first attempt to develop a RUG-III based case-mix system for long-term community-based clients. Significant proportions of the differences between clients' weekly cost of care were explained by our two models. The basic model, using only a system directly derived from the nursing home RUG-III system, performed well. By adding IADL measures, we formed a slightly more sophisticated RUG-III/HC model with improved performance. Both systems require only the information provided in the

MDS-HC. The CMIs of the RUG-III/HC groups followed patterns that would be expected of a hierarchical system, and were similar to those computed for long-term care residents in the nursing home. However, the sample sizes were not large enough to provide stable CMI estimates of all groups. The study was also limited to the particular type of long-term home care clients in the waiver program of the State of Michigan.

The success of the RUG-III/HC model indicates the potential of developing an integrated case-mix system for the full range of community and institutional based long-term care. Acknowledging the important role of IADLs in home care, we chose to use them to refine the RUG-III system, and this proved to be a plausible approach. Other variables which can explain cost variance could help to further refine the RUG-III/HC. The MDS-HC assessment instrument provides a broad range of additional information on client characteristics that could be useful in such analysis. Whether the clinical categories of the RUG-III case-mix system are relevant for home care clients other than those that are considered "long-term" is debatable. Several of the major categories (e.g., Extensive Services, Special Care or Rehabilitation) are unusual in the home care environment, but are still seen even in this sample. Our goal was to design a system that was compatible with the nursing home system, so it was important to retain the major RUG-III structure. The hierarchy makes sense for nursing home residents. As some of those in home care would be in a nursing home were it not for the home care programs, applying nursing home classification categories may make sense. With a low prevalence of several of the RUG-III/HC categories, the hierarchy achieves a more modest variance explanation here than that seen in the nursing home. It should be noted that the hierarchy, even in nursing homes, was not the variable with the highest variance explanation (that was ADLs); rather, it was used because of its clinical rationale in separating out very different types of patients. It may still validly fulfill that role in the home care setting.

The effect of including agencies' identifiers was only a moderate increase of the variance explanation, after controlling for case-mix. We regard this as encouraging from the perspective of developing a case-mix adjusted prospective payment system. The low correlation between agency and resource use, after controlling for case-mix, indicates that there is less variation in practice patterns than previously found (3). However, this finding may be the result of relatively similar care planning patterns across the Area Agencies on Aging, and the heavy involvement of informal care time in the specification of our dependent variable.

The analysis suggests the need to incorporate informal care in developing a case-mix measure for home care. The variance explanation of weighted formal care time achieved by the RUG-III/HC system was low, especially when rehabilitation groups were omitted. These groups are partly self-explanatory as residents are classified into the Special Rehabilitation category based on the provision of rehabilitation services. Fur-

ther, the CMIs computed on only formal care time indicated small differences in cost between groups within each clinical category, in contrast to those computed using a dependent variable of both formal and informal care time. This suggests that informal care plays a key role in ADL and IADL support. As seen in Figure 3, the proportion of informal care also tends to increase with greater functional dependency. The fact that clients living alone received less care time must be regarded as sensible: individuals who live alone will almost assuredly receive less informal care time than individuals with similar disabilities living with others. However, controlling for this factor in the analysis did not affect the relative differences between groups' CMIs.

It should be noted that informal care time was assessed based on the actual time provided by informal caregivers. Therefore, the balance of informal and formal care time measured may not represent a true trade-off. It is possible that informal caregivers provide services that would not be given by formal caregivers, or that informal caregivers are less productive. Also, self-reported care time may be biased both by living arrangement (it is perhaps more likely that caregivers who do not live with the client have slightly more accurate estimates of the amount of care they provide than those that live with the client) and by the fact that it is often difficult for caregivers to separate the work they do to assist the older or disabled individual from the work they would have done anyway. However, if these "auxiliary" services and perhaps "biased" estimates were distributed evenly between groups, they would not affect the relative difference in cost between RUG groups. In our analyses, we decided to weight informal care time less than categories of formal care, possibly accounting for some of the productivity differences. Also, our sensitivity analysis showed that using different levels of wage weights for informal care did not greatly affect the relative difference of cost between RUG-III/HC groups. The question whether informal care should be considered as a substitute for formal care or be treated as a separate input in the production function of long-term home care (with some specified cost) is more a political than a scientific issue.

Applying case-mix systems for payment in home care is becoming an important policy in the United States and elsewhere. It seems evident from our analysis that preserving incentives for providing informal care represents a major challenge. To preserve these incentives, a voucher type of payment system may be an option for long-term home care, e.g., giving a portion of the payment to the client in the form of a voucher which can be used to buy formal care services or be kept to reimburse informal caregivers. However, more analysis is needed of the trade-off between formal and informal care, and better guidelines for measuring the cost of informal care need to be developed. Other issues relevant for developing case-mix based payment systems for home care include the health status and professional status of the informal caregiver. In this study, we had no

information on these variables. Whether the large amount of informal care found in this study is unique to this sample should also be tested, a task we will address as we obtain data from other settings for home care in the U.S. and abroad. Nevertheless, the findings of this study suggest that a case-mix classification for long-term home care can be successfully developed augmenting the RUG-III system.

Note

1   The CMIs and CVs of the basic RUG-III model can be obtained from the authors.

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