Resident Outcomes in Small-House Nursing Homes: A Longitudinal Evaluation of the Initial Green House Program

Rosalie A. Kane, PhD, Terry Y. Lum, PhD,† Lois J. Cutler, PhD,* Howard B. Degenholtz, PhD,‡ and Tzy-Chyi Yu, MHA**

OBJECTIVES: To determine the effects of a small-house nursing home model, THE GREEN HOUSE® (GH), on residents' reported outcomes and quality of care.

DESIGN: Two-year longitudinal quasi-experimental study comparing GH residents with residents at two comparison sites using data collected at baseline and three follow-up intervals.

SETTING: Four 10-person GHs, the sponsoring nursing home for those GHs, and a traditional nursing home with the same owner.

PARTICIPANTS: All residents in the GHs (40 at any time) at baseline and three 6-month follow-up intervals, and 40 randomly selected residents in each of the two comparison groups.

INTERVENTION: The GH alters the physical scale environment (small-scale, private rooms and bathrooms, residential kitchen, dining room, and hearth), the staffing model for professional and certified nursing assistants, and the philosophy of care.

MEASUREMENTS: Scales for 11 domains of resident quality of life, emotional well-being, satisfaction, self-reported health, and functional status were derived from interviews at four points in time. Quality of care was measured using indicators derived from Minimum Data Set assessments.

RESULTS: Controlling for baseline characteristics (age, sex, activities of daily living, date of admission, and proxy interview status), statistically significant differences in self-reported dimensions of quality of life favored the GHs over one or both comparison groups. The quality of care in the GHs at least equaled, and for change in functional status exceeded, the comparison nursing homes.

CONCLUSION: The GH is a promising model to improve quality of life for nursing home residents, with implications for staff development and medical director roles. **J Am Geriatr Soc 55:832–839, 2007.**

Key words: nursing home; culture change; quality of life; longitudinal outcomes; quality indicators

After a critical 1986 Institute of Medicine report,[1] regulatory reform in nursing homes was launched, aimed at improved quality assessment, monitoring, and enforcement. A 2001 Institute of Medicine report noted improvements in overall health care but little reduction of societal dread of nursing homes[2] or improvement in quality of life.[3] The problems of maintaining a sense of well-being in a nursing home are well documented in decades of anthropological, ethnographic, and ethics studies.[4–9] Efforts to combat residents' learned helplessness with increased choices have resulted in measurable health benefits.[10–14]

A movement for culture change in nursing homes has gathered force since 1995, embracing transformed physical environments (e.g., smaller-scale, more-private rooms and baths and household-type neighborhoods for dining and occasionally cooking), transformed staff roles with more empowerment of line staff, and a philosophy of individualized care.[15,16] The "Eden Alternative," a set of principles overlaid on existing nursing homes to flatten hierarchies, invest decision-making in residents and frontline staff, and normalize nursing home life, addressed psychosocial problems of residents, such as loneliness, boredom, helplessness, and lack of meaning.[17] Eden training has been widely sought, but the few formal evaluations had unimpressive results,[18,19] suggesting that, without more-systemic changes in nursing homes, this model will have limited effects. In contrast, THE GREEN HOUSE® (GH) envisages a radically reconfigured nursing home.[20] The current study determines the effect of the GH on the quality of care in nursing homes and compares the quality of life of GH residents with that of those in conventional nursing homes. It was hypothesized that resident quality of life and satisfaction would be greater in the GH than in the comparison settings and that functional status and quality-of-care indicators

From the *Division of Health Policy and Management, School of Public Health, and †School of Social Work, University of Minnesota, Minneapolis, Minnesota; and ‡Department of Health Policy and Management, Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania.

Address correspondence to Rosalie A. Kane, PhD, Division of Health Policy and Management, School of Public Health, University of Minnesota, 420 Delaware St. SE, D527 Mayo Building, MMC Box 197, Minneapolis, MN 55455. E-mail: kanex002@umn.edu

DOI: 10.1111/j.1532-5415.2007.01169.x

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0002-8614/07/$15.00

would be at least equal to those of the conventional nursing homes.

METHOD

Design

The organization sponsoring the first GH to be implemented considered that randomization of residents to the GH was unfeasible, partly because money was initially raised to relocate the first 20 residents from a locked dementia care unit. Instead, the intervention was tested in a longitudinal quasi-experimental design. Two comparison settings were used: the sponsoring nursing home (Cedars) and another nursing home of the same nonprofit owner on a similar campus in a Mississippi community approximately 90 miles away (Trinity). Data came from in-person interviews with residents, family members, and line staff and from abstraction of the nursing home Minimum Data Set (MDS) for times preceding and most proximate to in-person data collection. (This first set of results reports data from and about residents and does not describe the methods and measures for studying family and staff outcomes.) The University of Minnesota institutional review board approved the study, informed consent was obtained for all primary data collection and chart reviews, and privacy requirements under the Health Insurance Portability and Accountability Act requirements were observed for using the MDS data.

The two comparison groups, Cedars and Trinity, each have strengths and limitations. The Cedars group was susceptible to contamination by having a shared administration with the GH and was potentially influenced by the GH planning and the ultimate goal of moving all residents to GHs; this could have led to spin-off improvements in the Cedars group or poorer results at Cedars because of neglect of the traditional nursing home and concentration on the GH. Although under the same ownership and experiencing similar local conditions, Trinity is a smaller nursing home with a subacute capability. The Trinity group represents the "natural history" of residents in a traditional nursing home setting in the same region and time period.

Sample

Figure 1 displays the sample for each setting at each time period.

Green House

The GH sample comprised the 40 people who were scheduled to move to the GHs at baseline and the current GH

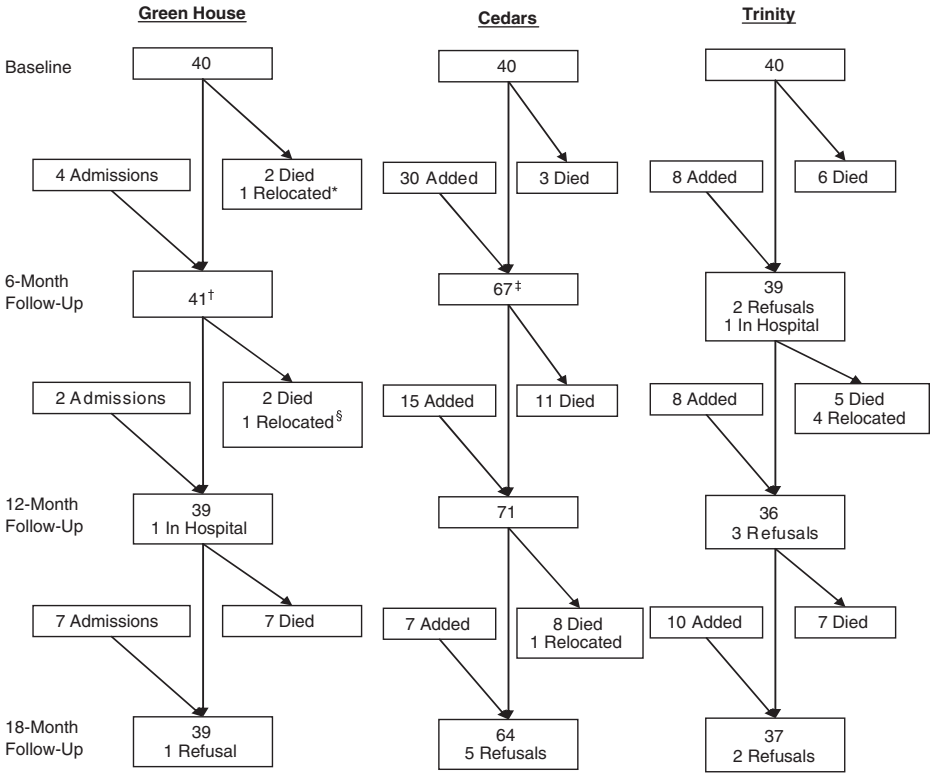

Figure 1. Sample sizes and disposition at each time point of data collection. Each box shows the number of completed interviews at each time point at each site. Additions to the sample at THE GREEN HOUSE® (GH) are due to new admissions; at any time, the total Green House capacity was 40. At Cedars and Trinity, subjects who died or relocated were replaced using random sampling within the respective facility to keep sample sizes stable.*One resident who had relocated returned to Cedars at own and family request. †One resident was interviewed and died, and her replacement was also interviewed, accounting for the 41 subjects. ‡After baseline, Cedars was oversampled in an attempt to acquire baseline data from residents likely to enter GH at subsequent periods, resulting in larger numbers of subjects. §At 6 months, one GH resident was asked to leave and went to another nursing home. ‖The sample at Trinity dropped below 40 because, after exclusion of residents who were on Medicare and those who were comatose or vegetative, residents younger than 65 and those who refused, the eligible population was less than 40.

census at each of the three follow-up periods—6 months, 12 months, and 18 months. All told, 53 GH residents were eligible over the successive data collection periods, 52 of whom were in the sample. Ten of the GH sample members died over the 18-month period, and two were discharged.

Cedars

During the study period, the maximum census remaining at Cedars was 80. At baseline, a random sample of 40 residents was sought, excluding residents who were comatose, vegetative, or in end-stage palliative care; nine of the initial group approached declined to participate. In subsequent waves, to acquire as much baseline data as possible from residents who might later move to GHs, the Cedars sample was enlarged, with a goal of 70 per time period. The added sample members at all follow-up waves were randomly selected. The final Cedars sample sizes were 67, 71, and 64 for the three follow-up waves, with refusals from three, zero, and one person, respectively. The only live discharges from Cedars were to GHs, affecting six sample members; 22 of the Cedars sample died during the study period.

Trinity

Trinity had a capacity of 65 beds, 15 of which were in a Medicare unit. A sample of 40 residents was sought from the non-Medicare portion of Trinity, using the same exclusion criteria as at Cedars. The Trinity sample at the three follow-up waves was 39, 36, and 37, respectively. Sixty-six people participated from Trinity; 18 sample members died over the 18 months, and four were discharged alive.

Sample for Quality Indicators

The sample in all three settings for quality indicators (QIs) is larger than the sample for direct data collection. It comprised all those in the settings during each of three 6-month time periods, because it used MDS records for each setting.

Intervention

GHs are self-contained dwellings for seven to 10 residents needing nursing home levels of care. The physical environment is residential, offering residents opportunities for privacy (with private rooms and full bathrooms) and for community (with a residential-style kitchen where meals are prepared on site, communal dining tables, hearth areas, and accessible outdoor space). The GH avoids nurses' stations, medication carts, and public address systems. The frontline care staff members, who are certified nursing assistants (CNAs) assigned to a single GH, have broadened roles, including cooking, housekeeping, personal laundry, personal care to residents, implementation of care plans, and assisting residents to spend time according to their preferences. All professional personnel mandated in regulations (e.g., nurses, physicians, social workers, dietitian, pharmacist, therapy staff, and activity personnel) form visiting clinical support teams that provide specialized assessments and order and supervise care within their spheres of expertise. The CNAs report to an administrator (called a "guide") rather than to a nurse. Philosophically, the GH model emphasizes individual growth and development and a good quality of life under normal rather than therapeutic circumstances.[20] A group of GHs on a campus or scattered in a residential neighborhood operates under a nursing home license and within a state's usual Medicaid reimbursement amounts, although a redistribution of expenditures could occur.

Four GHs were built on the campus of a nonprofit retirement complex comprising independent housing, assisted living, and a nursing home licensed for 140 beds. In June 2003, residents from the sponsoring nursing home occupied these GHs; two GHs were initially earmarked for residents in the locked dementia care unit (which was then closed), and residents from the general nursing home population occupied the others. The latter were filled from a list of residents voluntarily interested in moving, taken in order of the length of time that the residents had been on the campus. Residents already in the nursing home or on the campus similarly filled vacancies arising in the GHs after the initial move-in, again in order of length of time on the campus. A fuller description of the general model, its theoretical rationale, and its first implementation has been published.[20]

Data Collection

Data collectors (16 in total) from the local area received a 40-hour training at each wave. The resident protocol included administration of informed consent, a component administered to each resident (requiring about 45 minutes), and a component administered to staff about each resident's functioning. Interviewers physically visited all residents at each wave of data collection and turned to a family proxy only if residents could not be roused for an interview or could not respond coherently to successive questions. (The protocol for proxy use mirrored the procedures employed when the quality-of-life measures were developed and found reliable for persons with substantial dementia.[21]) Eligible proxy respondents must have visited the resident in the last month, and most were more intensively involved. Baseline data collection pertaining to the period before move-in to GHs began in May 2003. The 6-month follow-up began in December 2003, the next wave in May 2004, and the final wave in December 2004. Each data collection phase took approximately 6 weeks to complete.

Measures

Quality of Life

Eleven domains of quality of life were measured: physical comfort, functional competence, privacy, dignity, meaningful activity, relationship, autonomy, food enjoyment, spiritual well-being, security, and individuality. These domains scales comprised three to six items; each is standardized to a theoretical range of 4 to 1, by dividing the total score by the number of items. Most items used a 4-point ordinal scale (4 = often, 3 = sometimes, 2 = rarely, 1 = never); reverse coding was used for items so that a higher score always represented better quality of life. Those unable to respond to a Likert-type scale after three attempts (due to cognitive limitations) were asked the question with a "mostly yes" or "mostly no" choice. After empirical testing, these responses were extrapolated into the 4 to 1 scale, with a score of 3.8 for the affirmative and 1.5 for the negative responses. These measures have been tested in a large sample and have reliable scale properties, test-retest reliability, and concurrent

validity, and the domain scales have been shown to comprise separate but related measures of an underlying quality-of-life construct.[21]

Health and Functioning

Residents rated their health as excellent, very good, good, fair, or poor. Ability to perform activities of daily living (ADLs) "in the last few months" was measured according to self-report using five items: bathing, dressing, transferring from bed, using the toilet, and eating. Ability to perform instrumental activities of daily living (IADLs) was measured using six items: taking medicine, using the telephone, preparing food, light housekeeping, managing money, and doing laundry. For all ADL and IADL items, residents were asked whether they did the function by themselves, got a little help, got a lot of help, did not do it at all, or were not allowed to do the task; higher scores represented greater impairment.

Satisfaction

Global satisfaction was measured using three items: satisfaction with your nursing home as "a place to live," and as "a place to receive care" (both on a 4-point scale from very satisfied to very dissatisfied) and likelihood of recommending the setting to others (on a 4-point scale from very likely to very unlikely).

Emotional Well-Being

Emotional well-being was measured using an adaptation of a scale previously developed,[22] whereby residents were asked to rate how they had been feeling "lately" on 10 positive or negative emotional states: lonely, happy, bored, angry, worried, contented, sad, afraid, interested in things, and looking forward to the future; response choices were often, sometimes, rarely, and never. An additive scale with a range of 10 to 40 was developed by reverse coding the negative emotions; alpha reliability was 0.74.

Other Variables

Also included in the data set were sex, age, and time since admission (in months). For case-mix adjustment, ADLs (bed mobility, eating, transferring, and toileting) and cognitive functioning were extracted from the MDS and calculated using methods developed previously.[23,24] Social activity was measured according to self-reported frequency of participation in nine activities: leaving the grounds for organized activities, leaving the grounds for privately organized activities, staying away overnight, having an overnight guest in the nursing home, having a good conversation with any other resident, doing solo activities of personal interest, receiving visits from family or friends, and communicating by phone with family or friends.[25] The response set was every day, more than once a week, about weekly, less than weekly but more than once a month, about once a month, or not at all.

Quality Indicators

The 24 QIs were constructed from the MDS for residents in the GH, in Cedars, and in Trinity using assessments for the following time periods: between baseline and 6 months, between 6 and 12 months, and between 12 and 18 months after the GHs were operating. (Although Cedars and GH were a single nursing home for federal MDS reporting, the data were separated for these analyses.) The QIs were constructed by adapting methods used previously[26] to include indicator-specific clinically derived adjustors as used in evaluations of quality of several managed care programs for elderly nursing home residents.[27,28]

Data Analysis

Stata version 9 was used for all data analyses (StataCorp., College Station, TX). Selection effects were examined by comparing baseline characteristics (independent and dependent variables) of the sampled residents who went to the GH, remained at Cedars, or were in Trinity. Outcomes were analyzed using multivariate panel regression analyses using the random-effects regression models; these used the data from the three follow-up periods over 18 months; baseline data were used only for case-mix adjustment. Wave of data collection was accounted for using dummy variables. The main independent variable was the resident's status as a GH, Cedars, or Trinity resident at the time of data collection. Data from the baseline interviews were used only to check for selection effects.

All analyses for self-reported outcomes were controlled for sex, age, time since admission, baseline ADL from the MDS assessment just before the subject entered the sample, and self-report versus proxy report. Because MDS cognitive function and proxy status were collinear, the analyses were run separately, adjusting for baseline MDS cognitive function, with almost identical results. The results that control for proxy status are therefore reported as more reflective of cognitive status at the exact time of the resident interviews.

The difference in residents' quality of life between the three nursing homes were analyzed using the random-effects Tobit model, chosen to take into account the nature of repeated measurements in this data set and floor and ceiling effects. Floor effects were absent in all quality-of-life domains except for autonomy (3%) and functional competence (17%). Ceiling effects were present in most domain scales, ranging from moderate (e.g., 24% for privacy and 32% for the food enjoyment subscale) to severe (e.g., 53% for dignity). Differences in self-reported health, satisfaction, and emotional well-being were studied using random-effects Ordered Probit regression models, chosen because the measures for these analyses were ordinal.[29] Differences in self-reported ADLs and IADLs were studied using random-effects population-averaged linear models. Testing was undertaken for possible interactions between proxy status and setting (Cedars, Trinity) in all models using a postestimation Wald test.

The differences in MDS QIs between GH and the other two nursing homes were examined using random-effects logit regression combining data from the three follow-up periods and including dummy variables for wave of data collection.

RESULTS

Samples at Baseline

Only two significant differences at baseline were found across the groups; residents remaining at Cedars had a significantly longer length of stay than those who went to

Table 1. Characteristics of Residents at Baseline

Characteristic	Green House*		Cedars		Trinity	
Sample size, *n*	40		40		40	
Female, %	80.0		87.5		75.0	
White, %	75.0		95.0†		95.0†	
Proxy, %	62.5		70		50	
Age, mean (SE)	81.4	(10.4)	87.0	(9.2)‡	88.6	(7.7)§
Days from admission, mean (SE)	682.0	(552.3)	1,193	(1,555)	1,108	(988.0)
Cognitive performance, mean (SE)‖	2.8	(1.92)	3.7	(1.4)	3.2	(1.8)
ADLs, mean (SE)¶	7.0	(5.7)	8.6	(5.8)	8.4	(5.8)

* Bivariate analyses used the Green House as the reference for tests of significance. One-way analysis of variance or chi-square tests were used depending on the type of variable.
Significant difference from Green House: $P =$ †.006; ‡.008; §.001.
‖ Cognitive performance is measured from the Minimum Data Set; possible score range 0 to 6, with the higher scores reflecting more-severe cognitive impairment.
¶ Ability to perform activities of daily living (ADLs) measured on a scale of 0 to 16, with higher scores reflecting greater impairment.
SE = standard error.

the GHs, and the GH had more African-American residents: 25% at baseline, compared with 5% at Trinity and Cedars (Table 1). The group who moved from the dementia special care unit accounted almost entirely for the difference in race; eight of those 20 residents were African American. No significant differences were found in age, sex, self-reported health, baseline ADLs, cognitive function, length of stay, or proxy status. No baseline differences were found in any of the 19 baseline outcomes measured (data available from author).

Effects on Resident Outcomes

Quality of Life

Table 2 shows the results of random-effects Tobit regressions of quality of life. GH residents reported better quality of life than Cedars residents on seven of the 11 quality of life subscales (privacy, dignity, meaningful activity, relationship, autonomy, food enjoyment, and individuality). GH residents reported higher quality of life than Trinity residents on four of the 11 measures (privacy, dignity, autonomy, and food enjoyment). GH residents did not report lower quality of life on any of the 11 measures than residents in Cedars or Trinity.

Table 3 shows the results of random-effects Ordered Probit regression on self-reported health, satisfaction, emotional well-being, functioning, and mobility. GH residents reported better emotional health than residents in Cedars. There was no statistically significant difference in self-reported health, ADLs, or IADLs across the three nursing homes. The results of the random-effects Ordered Probit regression on satisfaction showed that, GH residents reported significantly higher satisfaction with the nursing home as a place to live than residents of Cedars and Trinity and significantly higher satisfaction as a place to get care than residents of Cedars. They were also more likely to recommend the facility to others. GH residents had significantly better emotional well-being scores than Cedars residents.

The test for possible interactions between outcomes and proxy status revealed only one significant interaction. The use of proxy informants was associated with lower

Table 2. Effects of Green House on Quality-of-Life Scales

	Cedars			Trinity		
Quality-of-Life Scale*	Coefficient (Standard Error) *P*-value					
Comfort	−0.022	(0.07)	.74	0.06	(0.08)	.44
Functional competence	−0.122	(0.18)	.48	−0.09	(0.19)	.62
Privacy	−0.818	(0.12)	<.001	−0.27	(0.14)	.05
Dignity	−0.690	(0.13)	<.001	−0.56	(0.15)	<.001
Meaningful activity	−0.261	(0.08)	.003	−0.07	(0.10)	.79
Relationship	−0.353	(0.11)	.002	−0.08	(0.13)	.51
Autonomy	−0.439	(0.12)	<.001	−0.27	(0.14)	.05
Food enjoyment	−0.772	(0.16)	<.001	−0.65	(0.18)	<.001
Spiritual well-being	−0.266	(0.13)	.03	0.22	(0.14)	.12
Security	−0.108	(0.05)	.04	0.06	(0.06)	.34
Individuality	−0.475	(0.10)	<.001	−0.16	(0.12)	.17

Note: Random effects Tobit regression analyses with the Green House as reference group, controlled for sex, age, length of stay, proxy respondent in resident interview, baseline ability to perform activities of daily living (from the Minimum Data Set), and wave of data collection.
* Each quality-of-life scale was standardized from 4 to 1, with higher scores representing better quality of life.

Table 3. Effects of Green House on Self-Reported Health, Satisfaction, and Functioning

Outcome Measured	Cedars			Trinity		
	Coefficient (Standard Error) *P*-value					
Self-reported health*	−0.03	(0.16)	.86	−0.17	(0.18)	.37
Emotional well-being†	−1.82	(0.77)	.01	−1.68	(0.89)	.06
Satisfaction with:‡						
Nursing home as a place to live	−1.75	(0.29)	<.001	−1.11	(0.31)	<.001
Nursing home as a place for care	−1.32	(0.29)	<.001	−0.64	(0.32)	.04
Would recommend to others§	−1.45	(0.27)	<.001	−0.67	(0.29)	.02
ADLs‖	0.42	(0.44)	.34	−0.48	(0.50)	.34
IADLs¶	0.23	(0.48)	.63	−0.25	(0.54)	.64

Note: Random-effects regression analyses with the Green House as reference group, controlled for sex, age, length of stay, proxy respondent in resident interview, baseline activities of daily living (ADLs) from Minimum Data Set, and wave of data collection.

* A single item measured on a scale of 5 to 1, with 5 reflecting the best self-perceived health.

† Composite measure of 10 emotions, each measured on a scale of 1 to 4. The summed scale has a theoretical range of 10 to 40, with higher scores reflecting higher reported emotional well-being.

‡ Each of the two items was measured separately on a scale of 4 to 1, with 4 reflecting the greatest satisfaction.

§ Measured on a scale of 4 to 1, with 4 being the greatest likelihood of recommending.

‖ Five ADL items, each measured with a 0 to 3 score, were summed for a theoretical range of 0 to 15, with higher scores reflecting greater ADL impairment.

¶ Six instrumental activity of daily living (IADL) items, each measured on a scale of 0 to 3, were summed for a theoretical range of 0–18, with higher scores reflecting greater IADL impairment.

meaningful activity scores for Cedars residents (−0.381 vs −0.201, $P=.001$).

At baseline, no differences were found according to setting for any of the nine social activities measured. With the three follow-up samples combined and with the usual controls, the likelihood of participating in organized activities in the facility (e.g., games, performances, religious services) was greater at Cedars (coefficient 0.56, $P=.002$) and Trinity (coefficient 0.65, $P=.001$) than at the GH, but organized trips away from the setting were less likely at Cedars (coefficient −0.61, $P=.001$) and even less likely at Trinity (coefficient −0.80, $P<.001$). The GH group was just as likely to engage in solo activities, receive phone calls and visits, take privately arranged trips from the setting, or have an overnight guest as the comparison groups.

Effects on Quality of Care

Table 4 shows the effect of GH on MDS QIs relative to Cedars and Trinity. The GH had a lower prevalence of residents on bed rest, fewer residents with little or no activity, and lower incidence of decline in late-loss ADLs than Cedars. The GH had a lower prevalence of depression and lower incidence of decline in late-loss ADLs but a higher prevalence of incontinence than Trinity. Three of the 24 QIs could not be calculated because of sample size; there were no occurrences of new fractures in the GH or Trinity in the 18 months and four new fractures at Cedars, there was no dehydration in the GH and only one occurrence each at Trinity and Cedars, and there was no fecal impaction in any of the settings.

DISCUSSION

Summary

The results strongly favor the GH and suggest that it achieved its stated goals. GH residents had higher quality of life on nine of the 11 domains than did residents at Cedars and on four domains than did residents at Trinity, were much more satisfied than residents in either comparison setting, and had better emotional well-being than residents at Cedars. On the QIs, the GH was superior to Cedars on three indicators and to Trinity on two. The GH had a lower incidence of decline in late-loss ADL functioning than either of the other two settings. The only difference favoring a comparison group for the 20 indicators that could be calculated was the higher rate of incontinence in the GH than at Trinity. On 16 indicators, GH performance equaled that of the comparison groups.

The finding that GH residents equaled the comparison groups in seven areas of social activity allays concerns that the GH model offers insufficient resident stimulation, because organized activities are underemphasized, and although GH residents were less likely to participate in organized activities, they were more likely than either comparison group to participate in organized social outings off the grounds. Furthermore, no reduction and some improvement was found in quality-of-life appraisals of meaningful activity and relationships.

Limitations

The study could not be randomized, and although the samples were similar in important ways, they differed in age and race. They may also have differed in unmeasured ways related to selection for the GH, given that the initial fill-up of two GHs and all replacements were done from a list of residents who volunteered. The sample was small and entailed studying a moving target, because the intervention evolved during the period. Generalizability to other settings establishing a GH and to a GH implemented across an entire nursing home can be done only cautiously. Results might also be different if residents moved to a GH from their own homes rather than from a traditional nursing home. Given the simultaneous innovations, it was impossible to isolate how various parts of the intervention—

Table 4. Effects of Green House on Quality Indictors (QIs)

QI	Cedars			Trinity		
	Odds Ratio ± Standard Deviation, *P*-value					
Incidence of new fractures*	NA*	NA	NA	NA	NA	NA
Prevalence of falls	2.10	± 1.00	.12	2.04	± 1.11	.18
Prevalence of behavioral symptoms	0.51	± 0.25	.17	1.56	± 0.85	.41
Prevalence of depression†	0.97	± 0.39	.94	2.47	± 1.05	.03
Prevalence depression without antidepressants	0.76	± 0.44	.64	1.72	± 1.02	.35
Use of ≥9 medications	1.49	± 0.73	.41	0.88	± 0.47	.80
Incidence of cognitive impairment	1.42	± 1.47	.74	2.12	± 2.39	.50
Prevalence of incontinence‡	1.30	± 0.85	.68	0.21	± 0.16	.03
Prevalence of incontinence without toilet plan§	NA	NA	NA	NA	NA	NA
Prevalence of indwelling catheters	1.05	± 0.83	.95	2.48	± 2.09	.27
Prevalence of fecal impaction*	NA	NA	NA	NA	NA	NA
Prevalence of urinary tract infections	1.60	± 0.74	.31	2.44	± 1.17	.06
Prevalence of weight loss	0.84	± 0.27	.59	0.92	± 0.32	.80
Prevalence of tube feeding	1.15	± 0.75	.83	0.32	± 0.25	.14
Prevalence of dehydration*	NA	NA	NA	NA	NA	NA
Prevalence of bedfast residents‡	3.70	± 2.10	.02	0.42	± 0.29	.21
Incidence of decline of late loss of ADLs‖	3.01	± 1.52	.03	3.88	± 2.05	.01
Incidence of decline of range of motion	1.80	± 1.01	.29	1.15	± 0.75	.82
Prevalence of antipsychotic use—high risk	1.87	± 1.02	.25	0.41	± 0.27	.18
Prevalence of antianxiety or hypnotic medications	1.41	± 0.84	.56	2.42	± 1.52	.16
Prevalence of hypnotic use >2 times	1.65	± 1.25	.51	0.65	± 0.55	.61
Prevalence of daily physical restraints	1.12	± 0.58	.83	0.75	± 0.43	.61
Prevalence of little or no activity¶	5.01	± 2.68	.003	0.88	± 0.54	.83
Prevalence of stage 1–4 pressure ulcer	1.18	± 0.66	.76	2.01	± 1.18	.24

Note: Differences in QIs were analyzed using random-effects logit regression models with the Green House as the reference group. Each QI was created with specific exclusions and adjustments, as applicable.[27,28] Specifications for all QIs are available from the authors; those with statistical significance are further in these notes.

* Unable to calculate the because of small sample size, low incidence of new fractures, and prevalence of dehydration or fecal QI in the settings. None of these adverse outcomes occurred at all in the Green House and rarely in the other settings for the samples during entire 18-month period.

† Adjusted for sex, age, cognitive performance score, cardiovascular accident, and Alzheimer's disease.

‡ Adjusted for comatose/vegetative state and end-stage disease.

§ Unable to calculate because of skewness; none of the eligible population with incontinence for this QI in all three settings had recorded toilet plans.

‖ Subjects totally dependent in activities of daily living (ADLs), comatose/vegetative, or without a prior ADL assessment were excluded. Adjustments were made for Cognitive Performance Score and Alzheimer's disease.

¶ Comatose/vegetative excluded. No adjustments.

NA = not applicable.

environments, scale, programming, staff arrangements, and philosophy—contributed to the results.

The sample was too small for an analysis of mortality. As GH replications increase, further research should examine mortality and hospitalization outcomes, perhaps using common datasets across GH projects.

Residents who entered the GH between waves were included in the study. The analytical models were repeated with dummy variables for the wave of entry to determine whether variable exposure to the GH was associated with differential outcomes. This analysis, available upon request, did not reveal any systematic differences in the effect of the GH on outcomes for residents who lived there for longer or shorter periods of time.

Staff were aware of being observed as part of an experiment. The risk of a Hawthorne effect here is greater because of the media, scholarly, and community attention lavished on the GH group and the lack of an "attention" intervention in the comparison settings. To partially test for this, the analyses were repeated using only the 30 individuals who had been in the GHs for the entire project period; it was determined that effects did not wane (analyses available on request). Nonetheless, in this real-world experiment, it cannot be discounted that a Hawthorne effect persisted through the whole study period, given that GH guides and even frontline personnel have been recognized as trainers for GH replications around the country. To the extent that a dramatically different work place and living environment results in sustained levels of enthusiasm among staff, residents, and families, the GH may be considered a success, but future replications should be studied in detail to determine whether "normalization" occurs and, if so, to what level of performance.

Implications

The GH entails sweeping and comprehensive changes, so much so that some proponents perceive it as the deinstitutionalization of a nursing home.[20,30] Many of the changes required abandoning orthodoxy—residents are in kitchens when meals are cooked despite hypothetical risks of infections, residents may be out of eye range of staff on patios or in their own rooms, maintenance therapy and activity tasks are largely done by frontline CNA-level staff rather than by

aides in the specialized departments of traditional nursing homes, the direct supervisory control of charge nurses is reduced.

Overall the positive differences between the GH and Cedars were greater than those between the GH and Trinity. This suggests that there were no positive spin-offs because of GH implementation on the campus, and reinforces the sponsor's view of the difficulties in operating a GH and a traditional model on the same campus. Indeed, based on its experience with the first four GHs, Cedars opened six more 12-person GHs. By November 2006, 112 residents were housed in 10 GHs, and the traditional facility was reduced to 28 beds, many used for a newly certified Medicare unit. In 2005, the Robert Wood Johnson Foundation began a replication project aimed at enabling 50 GHs to be opened in 5 years; projects participating in this initiative carry the trademark, GREEN HOUSE®. As the GH programs and similar small-house nursing homes proliferate, an accompanying research agenda is imperative. Future work should examine processes of implementation and management for sustaining the innovation. Inevitably, roles such as director of nursing or social work, activities staff, and in-service developer will change if nursing homes convert entirely to GHs, as will policies for admission and room transfer. Attending physicians and medical directors will be challenged to adapt their procedures so as to provide excellent chronic disease management in disaggregated nursing homes where CNA-level staff members, with whom physicians typically have less communication, are more central to the care and more empowered to monitor according to physician direction. Visits to GH residents are more likely to resemble a home-care visit than a nursing home visit. The GH also poses opportunities and challenges to providing posthospital recuperation, rehabilitation, and palliative care within GHs themselves.

ACKNOWLEDGMENTS

The authors thank project officer Mary Jane Koren for her support of the effort. Robert L. Kane made helpful comments on several earlier iterations of the manuscript. William Thomas and Judith Rabig of the National GH project at the time and Steven McAlilly and numerous staff of Methodist Senior Services of Mississippi, Cedars Health Care Center, and Trinity Health Care Center provided invaluable insights and encouragement.

Financial Disclosure: This research was supported by a grant from the Commonwealth Fund, New York, New York. Some of the baseline data collection was funded by the Robert Wood Johnson Foundation under a subcontract from the GH Project, then at the Center for Growing and Becoming, Sherburne, New York. None of the authors have any conflict of interests or financial interests related to the work described.

Author Contributions: All authors contributed to the study as part of a team, and the first four authors were intensively involved in the preparation of the manuscript. As principal investigator, Rosalie A. Kane had overall responsibility for study design and data collection and interpretation of results. Terry Y. Lum directed the statistical analysis and was involved in all phases of decision-making. Lois J. Cutler, coinvestigator, coordinated all phases of fieldwork. Tzy-Chyi Yu served as research assistant, working closely with Dr. Lum.

Sponsor's Role: None of the foundations funding this project had any role in the preparation and writing of this paper.

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