

# The Effect of Channeling on In-Home Utilization and Subsequent Nursing Home Care: A Simultaneous Equation Perspective

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**Objective.** This study explored the relationship between participation in a home/community-based long-term care case management intervention (known as the Channeling demonstration), use of formal in-home care, and subsequent nursing home utilization.

**Study Design.** Structural analysis of the randomized Channeling intervention was conducted to decompose the total effects of Channeling on nursing home use into direct and indirect effects.

**Data Collection Method.** Secondary data analysis of the National Long-Term Care Data Set.

**Principal Findings.** The use of formal in-home care, which was increased by the Channeling intervention, was positively associated with nursing home utilization at 12 months. However, the negative direct effect of Channeling on nursing home use was of sufficient magnitude to offset this positive indirect effect, so that a small but significant negative total effect of Channeling on subsequent nursing home utilization was found.

**Conclusions.** This study shows why Channeling did not have a large total impact on nursing home utilization. The analysis did not provide evidence of direct substitution of in-home care for nursing home care because the direct reductions in nursing home utilization due to other aspects of Channeling (including, but not limited to case management) were substantially offset by the indirect increases in nursing home utilization associated with additional home care use.

**Keywords.** Long-term care, in-home care, case management

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Of the nation's 26.4 million people age 65 and older living in the community, approximately 3.7 million people are impaired in their ability to perform activities of daily living (Rowland 1989). In addition to having a greater degree of functional impairment, members of this population are

more likely to suffer from poor general health and low socioeconomic status (U.S. Bipartisan Commission 1990). As a result, this population has great need for medical care and personal assistance, but possesses few resources to finance such care (Rowland and Lyons 1992).

While the federal government has initiated a variety of long-term care demonstrations to assess the potential impact of a variety of home/community-based care arrangements and services on an array of patient outcomes, few of these interventions have been widely adopted on a community level. In addition, unless elderly individuals need skilled care (and qualify for Medicare coverage) or are categorically poor and live in a state with generous Medicaid benefits, most frail elderly individuals still must rely on their own resources for the majority of their medical and social service needs.

Several factors are likely to heighten the extent of this problem over the next few decades, including the growth in numbers of people needing long-term care (Rivlin and Weiner 1988), the continuation of policies aimed at facilitating the discharge of frail elderly into the community (Iglehart 1986; U.S. Senate 1988), and the limited capacity of families and programs to provide needed care (U.S. Bipartisan Commission 1990). It has been suggested that one way of containing future home/community-based care costs is to reduce the scope and range of benefits covered (Kane 1988). Not all services provided by home/community-based long-term care interventions will directly enhance the well-being or reduce the risk of institutionalization for those served by these programs. Therefore, by identifying key elements that do directly affect these outcomes, policymakers may be able to achieve specific policy objectives while limiting the total costs of expanded home/community-based care.

The purpose of this study is to explore the relationship between participation in a comprehensive home and community-based long-term care case management intervention (known as the Channeling demonstration),

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use of formal in-home services, and subsequent nursing home utilization. Specifically, when the total effects of the Channeling demonstration are disaggregated into direct and indirect component parts, does the use of formal in-home care reduce the probability of need for nursing home care? It was hypothesized that the use of formal in-home care would be associated with a reduction in subsequent nursing home care due to the substitution of home care for institutional care.

Prior analyses of the national Channeling demonstration have assessed the total effects of this home/community-based long-term care intervention on a variety of patient outcomes (Corson et al. 1986; Applebaum and Harrigan 1986; Kemper 1988; Phillips, Kemper, and Applebaum 1988). Since reduced-form equations were estimated, the effects of the intervention were not analyzed through any of the variables in the model (i.e., dependent variables were not regressed on any other endogenous variables in these previous estimations).<sup>1</sup> Duncan (1975) explained that

if one cared to know only the total effect of the exogenous variable on the dependent variable, the reduced-form coefficient tells the whole story. But if one is interested in how that effect comes about, the greater detail of the structural model is informative. After all, in the reduced form, a great deal of the "structure" is buried in the rather uninformative variances and covariances of the reduced-form disturbances. (p. 61)

In this investigation, structural equation models were estimated since the primary interest was in determining how (rather than whether) the intervention affected the outcomes of particular interest. In order to gain insight into the mechanisms by which Channeling treatment group status affected subsequent nursing home utilization, a distinction has been made between the direct and indirect effects to provide a quantitative assessment of how the total results emerged.

## LITERATURE ON UTILIZATION OF SERVICES

The literature on use of in-home care has focused on three primary areas: (1) a description of the utilization experience of community-based elderly individuals (Soldo and Manton 1985; Rowland 1989); (2) predictors of home care utilization (Soldo and Agree 1989; Tennstedt and McKinlay 1989); and (3) intervention studies assessing the effect of demonstration service availability on experimental and nonexperimental program participants (Phillips, Kemper, and Applebaum 1988; Kemper 1988; Weissert and Cready 1988).

Those conducting and supporting research in this area initially hoped to find that home care would reduce institutionalization and total care costs

(Brecher and Knickman 1985). Over the past few years, however, models of home care utilization have been broadened to examine a wider array of patient outcomes (Benjamin 1992). Inconsistent findings have been reported with respect to improvements in patient or client well-being, few statistically significant declines in institutional use have been found, and increases in the use of home or community-based services have generally resulted from such community-based interventions (Kane 1988).

Benjamin (1992) noted that most studies on home care have failed to describe adequately the nature of the services being delivered and the variations in service use across the populations studied. Furthermore, he found that even fewer have made efforts to "at least speculate about what it was about those services that yielded positive (or negative) outcomes" (Benjamin 1992, 35). As a result, it would be worthwhile for investigators to assess the contribution of various components of home/community-based interventions when evaluating the impact of a given intervention on outcomes of particular research interest.

The literature on nursing home utilization has focused, among other things, on the effect of home/community-based interventions on nursing home utilization (Wooldridge and Schore 1986; Greene, Lovely, and Ondrich 1993a, b). While home and community care has been suggested to reduce nursing home use in the majority of the studies conducted over the past 20 years, both the absolute level of use and the reduction in use generally have been small. Of the 22 home/community-based studies reviewed by Weissert and Cready (1988), 14 used tests of statistical significance to compare the differences in their treatment versus control group rates. Of these 14, 4 had significant reductions in nursing home use rates. Eight studies reported significant differences in average days utilized. In all but one of these eight studies, reductions in use were reported.

Previous assessments of the effect of home/community-based care on home and nursing home utilization have focused on the total effect<sup>2</sup> of the intervention rather than on the structural relationships between program participation, use of formal in-home services, and subsequent nursing home utilization. As a result, prior research has not provided a quantitative analysis of how or why these effects occurred.

## OVERVIEW OF CHANNELING AND PRIOR STUDY FINDINGS

The Channeling demonstration was a home and community-based long-term care case management intervention funded by the federal government between 1981 and 1985 and conducted in ten sites throughout the United

States (Kemper 1988). The demonstration sought to substitute community care for nursing home care, reduce the costs of long-term care, and improve the quality of life of elderly individuals and the family and friends who cared for them (Carcagno and Kemper 1988).

The total effects of two intervention models were evaluated: the Basic Model, which included outreach, screening, care planning, service utilization, and client monitoring; and the Financial Control Model, which covered the same elements as the Basic Model, plus additional features such as a funds pool to finance Medicare- and non-Medicare-covered home/community-based care (Kemper 1988). Prior research revealed that formal community service utilization increased following implementation of the Channeling intervention. While home/community-based services increased under both models, the increases were more substantial under the Financial Control Model (Corson et al. 1986).

Analyses of nursing home utilization revealed that Channeling was successful in targeting an extremely frail population, but it did not appear to identify a population at high risk of nursing home placement, did not substantially reduce nursing home use, and did not result in total cost savings (Wooldridge and Schore 1986, Kemper 1988). Although under the Basic Model, there were statistically significant reductions of approximately 20 percent in various measures of use (e.g., nursing home days during the first six months and percent of the sample with any nursing home stay during the second six months), the magnitude of the total effects was smaller than had been anticipated (Wooldridge and Schore 1986, 98–99). Therefore, the reductions in nursing home use were not substantial enough to lead to a reduction in total costs.

Similarly, under the Financial Control Model, the pattern of treatment/control group differences was generally consistent with that under the Basic Model—slightly lower use on several alternative measures—but none of the differences were statistically significant (Wooldridge and Schore 1986). Given that only a relatively small portion of the population would have used nursing homes even without Channeling, it was not possible to substantially reduce nursing home use following implementation of this comprehensive case management and expanded home/community-based long-term care intervention (Kemper 1988).

Additional analyses were conducted to assess the impact of case management on subsequent services utilization (Brown and Phillips 1986). Ordinary least squares (OLS) and two-stage least squares (2SLS) estimations were performed on the Channeling data. However, the authors were unable to determine whether case management and other services reduced subsequent institutional use since “the (OLS) regression model failed to control fully for the differences between recipients and non-recipients,” and “it was difficult

to predict with much accuracy which sample members actually received case management and services" when using the 2SLS procedure (Brown and Phillips 1986, 101).

More recent analyses of the National Long-Term Care Data Set have focused on appropriate targeting of community-based services to improve the degree to which these services offset nursing home expenditures. Greene, Lovely, and Ondrich (1993a) applied an empirical model to the Channeling data set to assess the cost-effectiveness of Channeling's community services as a substitute for nursing home utilization. They found that 41 percent of those screened into the control group had some potential for net long-term care cost reduction through the use of program services. Although the optimal "community-based long-term care (CBLTC) service assignment emerges as a complex problem in which the risk reduction per CBLTC service dollar depends on the particular service/client combination" (Greene, Lovely, and Ondrich 1993b, 314), the authors concluded that "more cost-effective programs can, in principle, be operated at a reasonably large scale" (Greene, Lovely, and Ondrich 1993a, 186-187).

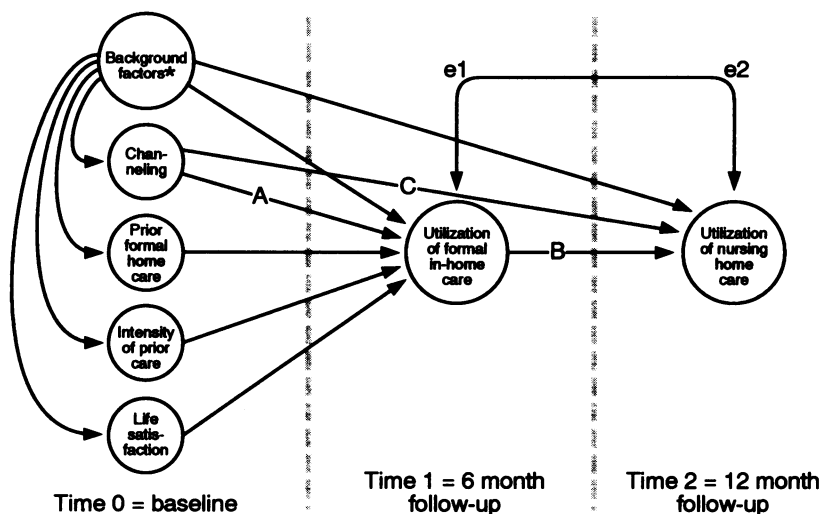
The Channeling demonstration was selected for use in this study because it provided the context necessary to determine how case management and formal in-home service delivery affected subsequent nursing home utilization. The data set contained a wide variety of health-related information on a large sample of elderly Americans, and multiple measurements were taken over time.

## CONCEPTUAL FRAMEWORK

The conceptual model was based on the Andersen and Newman (1973) model of the determinants of medical care, as shown in Figure 1. Groups of variables are depicted in this diagram. Participation in Channeling, and the following background factors were hypothesized to have a direct effect on home care utilization: age, gender, hours of informal support, homeowner status, race, marital status, availability of informal care, cognitive status, incontinence, percent applied to a nursing home or waitlisted, model site, activities of daily living (ADL) limitations, patient satisfaction, proxy status, Medicaid eligibility, prior formal home care utilization, intensity of prior home care utilization, and life satisfaction. Similarly, participation in Channeling, the utilization of formal in-home care at six months, and all but three background factors (i.e., prior home care utilization, intensity of prior home care, and life satisfaction at baseline) were hypothesized to have a direct effect on subsequent nursing home utilization.

Although the intensity and the use of prior home care services have been shown to be positively associated with subsequent formal in-home care

Figure 1: Important Domains: Nursing Home Utilization at 12 Months



\* Background factors = age, gender, hours of informal support, homeowner status, race, marital status, availability of informal care, cognitive status, incontinence, percent applied to a nursing home or waitlisted, model site, ADL limitations, patient satisfaction, proxy status, medicaid eligibility.

**Key**

- A = Direct effect of Channeling on home care utilization
- B = Direct effect of home care utilization on subsequent nursing home utilization
- C = Direct effect of Channeling on subsequent nursing home utilization
- (A x B) = Indirect effect of Channeling on subsequent nursing home utilization
- C + (A x B) = Total effect of Channeling on subsequent nursing home utilization

(Evashwick et al. 1984), these factors were not hypothesized to directly affect nursing home utilization up to 14 months later. Instead, these effects were anticipated to be mediated indirectly through the use of formal in-home care at six months. In addition, since life satisfaction is not known to be an important determinant of nursing home placement and no body of literature exists to support a direct association between life satisfaction and subsequent nursing home utilization, this baseline factor was not hypothesized to be directly associated with the use of nursing home services 12 months later. Instead, it was anticipated to be mediated indirectly through the use of formal in-home care at six months. Finally, since it was anticipated that a common set of unmeasured factors that were unavailable for inclusion in the model (e.g., severity of illness and medical diagnosis) would directly affect each utilization outcome (Brown and Phillips 1986), the correlation

between error terms ( $e_1$  and  $e_2$ ) was included as an additional parameter of interest in the model.

## HYPOTHESIZED RELATIONSHIPS BETWEEN KEY CONSTRUCTS

Detailed explanations of the hypothesized direct effects of all independent factors on the dependent factors are found in Rabiner (1993). The key hypothesized effects were that

- Participation in either intervention group would increase the use of formal in-home care at six months;
- Use of formal in-home care at six months would be negatively associated with use of nursing home care; and
- Once formal in-home care was included in the model, the direct effect of Channeling on subsequent nursing home utilization would be negative.

## SOURCES OF DATA AND SAMPLE CHARACTERISTICS

To be included in the analysis sample, potential subjects had to have completed the Channeling baseline questionnaire, plus both the six- and twelve-month follow-up questionnaires. Furthermore, potential subjects had *either* to: (a) be living in the community on their six-month anniversary date, or (b) if residing in a hospital/nursing home on their six-month anniversary date, to have lived in the community for at least two weeks during the previous six-month period. Only 2,109 of the original 6,326 individuals randomized into the Channeling sample satisfied these inclusion criteria and had complete information on all variables in the analysis.<sup>3</sup>

Since the 2,109 observations represented only 33 percent of the original sample, two analyses were undertaken to investigate possible sample selection bias. First, Heckman (1979) two-step estimation techniques provided no evidence that selectivity into the sample was likely to have affected study findings.<sup>4</sup> Second, supplementary analyses, using 3,347 observations (with mean values imputed for 1,238 cases with missing baseline data), yielded results that were similar in direction, magnitude, and significance.<sup>5</sup> Because of concerns about the correctness of using imputed values for baseline data, the final analysis sample consisted of 2,109 observations.

At baseline, most sample participants had at least some impairment with activities of daily living (ADL), about 32 percent were moderately



or severely cognitively impaired and about 44 percent were incontinent. Even so, only 5.9 percent had either applied to or were on a nursing home waiting list at the time of the baseline interview. Slightly more than 26 percent of sample members were eligible for Medicaid, almost 41 percent were homeowners, and over 32 percent relied to some degree on the use of proxies to complete the baseline questionnaire.<sup>6</sup>

## METHODS

Structural equation modeling techniques were used to analyze the nursing home utilization model. The objective of this approach is to account for covariances among observations across equations. Structural equation modeling is particularly useful when a researcher is interested in incorporating measurement error directly into the analysis, or estimating a complex multi-equation system. In this investigation, measurement error was taken into account in order to improve the quality of the inferences that could be made regarding the relationships among or between the variables of particular interest.

A second reason for using structural equation modeling was that it is designed to incorporate information from all of the equations into the model. A full information method was used to estimate this empirical model. The estimation was somewhat complicated by the fact that the data were found to have excessive multivariate kurtosis. As a result, it was necessary to generate weight and asymptotic covariance matrices to be used as the sources of data into subsequent weighted least squares model estimations. The PRELIS program (Joreskog and Sorbom 1988) was used to prepare the data for input into the structural equation modeling analyses.

Three sets of simultaneous equations were estimated using weighted least squares (WLS) in SPSS LISREL (1990).<sup>7</sup> Nursing home utilization, the final outcome in the model, was measured three ways: total days in a nursing home (log),<sup>8</sup> the probability of any nursing home stay between months 7 and 12, and the probability of still residing in a nursing home at the end of 12 months. Formal in-home utilization, the mediating variable in the model, was measured as the total (extrapolated) number of formal in-home visits received between months 1 and 6 (log) and calculated based on the number of visits received during a representative target week times the number of weeks in the community. Several goodness of fit indexes (e.g., the goodness of fit index, adjusted goodness of fit index, chi-square test, etc.) were used to assess the overall fit of the empirical model, and tests were conducted to determine the validity of each nursing home utilization model (Bollen 1989).

## RESULTS

Key results from the three simultaneous equation estimations of 12-month nursing home utilization are reported now. (The full set of WLS results are available from the lead author upon request). As anticipated (and found in the original Channeling evaluation), being in either intervention model increased the use of formal in-home care at six months across the three WLS estimations. (See Table 1). However, although formal in-home care was anticipated to decrease the use of subsequent nursing home care at twelve months (due to the substitution of home care for institutional care), using formal in-home services at six months was a strong positive predictor of subsequent nursing home utilization.

It was hypothesized that once formal in-home care was included in the model, other aspects of the intervention would have a direct negative effect on subsequent nursing home care. A statistically significant direct negative effect of Channeling on subsequent nursing home utilization was found for both intervention models. This result indicated that while use of formal in-home care at six months was positively associated with use of

Table 1: Relationships between Key Variables for Nursing Home Care at 12 Months WLS PRELIS/LISREL†

	<i>Total Days Months 7-12 (log)</i>	<i>Any Stay Months 7-12</i>	<i>In Nursing Home at End of Month 12</i>
<i>Equation One:</i>			
<i>Formal In-Home Care Utilization (log) at 6 Months</i>			
Basic Model	.103* (.019)	.095* (.019)	.103* (.019)
Financial Control Model	.262* (.024)	.245* (.024)	.259* (.024)
<i>Equation Two:</i>			
<i>Nursing Home Utilization at 12 Months</i>			
Utilization	.204*	.222*	.122*
Formal In-Home Care (log)	(.031)	(.014)	(.010)
Basic Model	-.068* (.014)	-.076* (.008)	-.033* (.005)
Financial Control Model	-.063* (.016)	-.063* (.008)	-.050* (.006)

\* $p < .01$ .

†This table provides the nonstandardized beta coefficients. Standard errors are in parentheses, and were calculated directly from the WLS/PRELIS program (Joreskog and Sorbom 1988).

nursing home care at twelve months (perhaps due to the fact that those using such services were more likely to be chronically ill), other aspects of the Channeling intervention directly decreased the use of nursing home care at twelve months.

To assess the total effects of Channeling on subsequent nursing home utilization, the direct and indirect effects of the intervention were combined.<sup>9</sup> Figure 1 shows the direct, indirect and total effects of the intervention on nursing home utilization in path diagram form. The results of both the disaggregation and summing of the structural equation model effects are shown in Figure 2.<sup>10</sup>

The total effects of the Basic Model were negative and statistically significant across the three twelve-month nursing home utilization outcomes. While the total effects of the Financial Control Model were negative across the three twelve-month nursing home utilization outcomes, only the reduction in the probability of still residing in a nursing home at the end of twelve months was statistically significant. In both models, the small but statistically significant positive indirect effect of Channeling (through the increased use of formal in-home care at six months) was more than offset by the slightly larger significant negative direct effect of the Financial Control Model on nursing home utilization at twelve months.

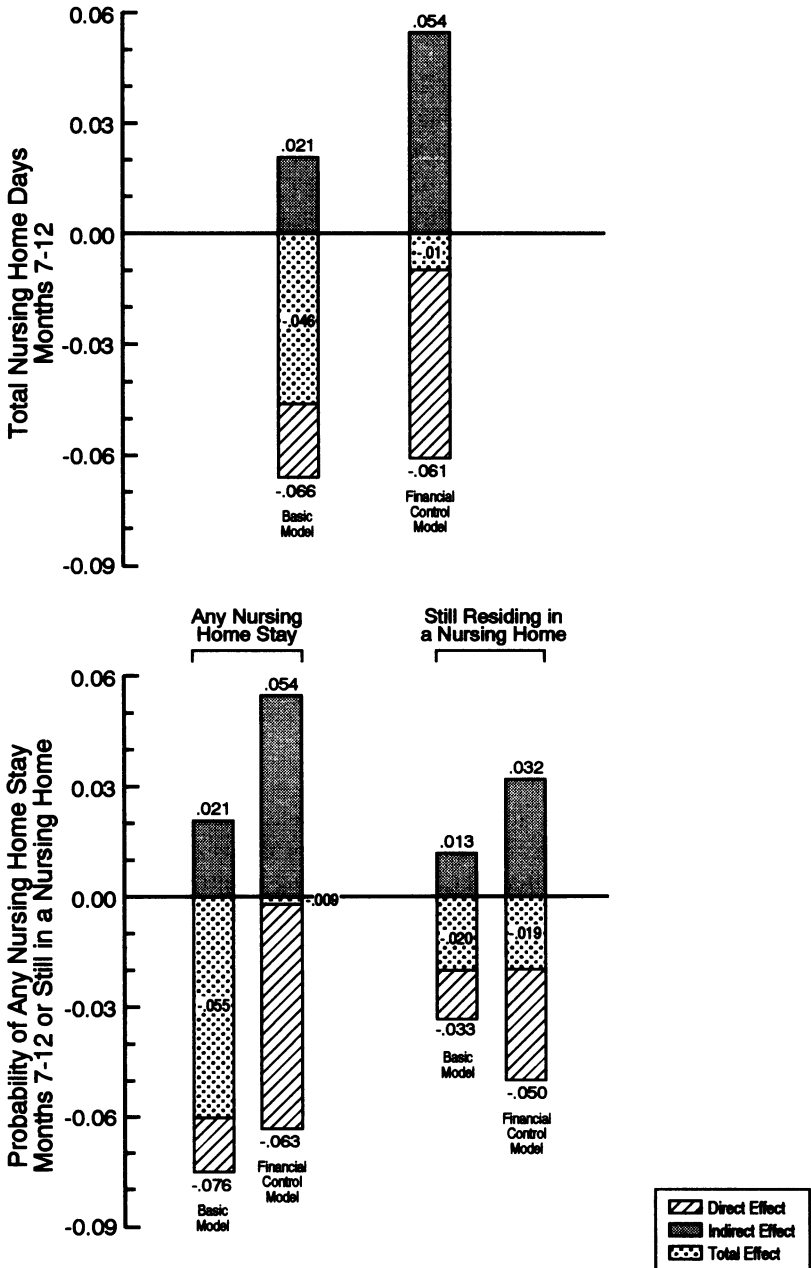
Several goodness of fit statistics were calculated (Bollen 1989). All of the overall goodness of fit indexes were very close to 1.0, indicating a good fit of the model to the data across nursing home utilization outcomes.

## DISCUSSION

Both intervention models achieved small reductions in total nursing home utilization at twelve months because the negative direct effect of Channeling was larger in magnitude than the corresponding positive indirect effect of each intervention model. As shown in Figure 1, the indirect effect was composed of two parts: the direct effect of Channeling on formal in-home care at six months (which was found to be positive, as expected), and the direct effect of formal in-home care on subsequent nursing home utilization (which was anticipated to be negative because of the substitution of home care, but instead was found to be positive).

Several factors may have caused the latter unanticipated finding. One possibility is that the use of in-home care increased the level of dependency of Channeling participants, thereby increasing subsequent nursing home utilization. While this argument may be contrary to expectations, a larger proportion of treatment (versus control group) members in the full study sample did report being disabled on each ADL task at six and

Figure 2: Direct, Indirect, and Total Effects of Channeling



twelve months, and the differences between groups on eating, dressing, and bathing and on the total ADL score were statistically significant for the Financial Control Model. Either client atrophy (due to the availability of formal in-home care) or a measurement artifact (resulting from the wording of questionnaire items) may have accounted for this result, although the Channeling research team was unable to determine which of these two explanations was more likely (Applebaum and Harrigan 1986).

A second, potentially more plausible explanation is that those using formal in-home care at six months were likely to be in poorer health than those who did not. To the extent that use of formal in-home care was a proxy for illness status at six months, those in need of formal in-home care at six months would be more likely to be at risk for institutionalization six months later. Therefore, these results should not be taken as specific evidence that the use of in-home care increases dependency.

When comparing the direct, indirect, and total effects of the intervention across the two Channeling models, two observations became noteworthy. First, while both models had negative direct and total effects on the three nursing home utilization outcomes, the negative direct and total effects of Channeling were generally larger in magnitude for the Basic Model than for the Financial Control Model. The larger total effect of the Basic Model may be explained by two factors: (a) the negative direct effect of Channeling was relatively larger in magnitude under the Basic Model, and (b) there were consistently smaller positive indirect effects under the Basic Model across the nursing home utilization outcomes. This finding is particularly surprising in that it was initially anticipated that the reduction in nursing home utilization would be *larger* for the Financial Control Model since funding for additional home/community-based services was available under this particular model (Corson et al. 1986; Kemper 1988).

Second, although the direct effect of Channeling was proportionately larger than the corresponding indirect effect for both intervention models, the indirect effect of Channeling was over twice as large in absolute magnitude for the Financial Control Model as for the Basic Model across all nursing home utilization outcomes. (This was due to the fact that the use of formal in-home care was greater under the Financial Control Model). As a result, the Financial Control Model led to a more substantial (absolute) indirect increase in subsequent nursing home utilization at twelve months.

## IMPLICATIONS FOR FUTURE RESEARCH

This study has shown why Channeling did not have a large total impact on nursing home utilization. Specifically, the direct reductions in nursing

home utilization due to other aspects of Channeling (e.g., case management) were substantially offset by the indirect increases in nursing home utilization associated with additional home care use. In light of this finding, if one were to argue for the funding of a Channeling-type intervention, it would be critical to modify the intervention to achieve net savings in total health care costs. One possible modification, suggested by other researchers, would be to target services to people at higher risk of institutionalization, for whom subsequent nursing home utilization could be delayed if not eliminated (e.g., those with significant chronic disabilities but with social support in the home).

Alternatively, if Channeling services were targeted to people at an earlier point in their disease progression, the services might be more successful in enabling individuals at risk for subsequent nursing home utilization to be adequately served in the community. It is possible that the favorable results of the intervention may have taken longer to realize than could be detected from the twelve-month follow-up period, or that the intervention came too late to affect the course of care for many demonstration participants. Had the intervention been evaluated over a longer period of time, a larger net reduction in subsequent nursing home utilization might have occurred.

It has been suggested that one way of containing future home/community costs is to reduce the scope and range of benefits covered (Kane 1988). To the extent that it was possible to "unbundle" services in this investigation, there was some evidence to justify the funding of case management as a long-term care policy option, since services other than home care (including, but not limited to case management) directly reduced subsequent nursing home utilization. In addition, when the Basic and Financial Control models were compared, the Basic Model generally did as well or better than the Financial Control Model in reducing subsequent nursing home utilization. Since the Basic Model, which was primarily a case management intervention, was also considerably less costly to fund over the duration of the intervention (Corson et al. 1986), it might be argued that the incremental costs of the Financial Control Model (over and above those of the Basic Model) were not justified.

This study provides an example of the way in which the health services research community can help policymakers to learn more about the linkages between different aspects of the long-term care delivery system, analyze program effects with the use of more sophisticated models, and gain a better understanding of how and why specific program effects may (or may not) be likely to occur. With such information in hand, policymakers may be better able to discriminate between, and choose among the many long-term care proposals circulating in Washington. It is believed that with the help, availability, and use of informative policy materials, those setting health care

policy for elderly Americans will be better able to determine where limited funds should be allocated to promote both efficiency and patient well-being.

## NOTES

1. There was one unpublished analysis of Channeling that did make use of a two-stage least squares estimation procedure to assess the effect of the intervention on subsequent services utilization (Brown and Phillips 1986), but the authors of this technical report did not provide a quantitative assessment of how or why the total effects occurred (i.e., the total effects of the intervention were not disaggregated into their direct and indirect component parts).
2. While this was the correct approach to follow when answering the questions posed by the Channeling research team, those investigating the total effects of Channeling were not able to ascertain quantitatively how the intervention affected subsequent nursing home utilization.
3. Reasons for loss to follow-up from initial sample ( $N = 6,326$ ) included: failure to complete the baseline sample member interview (619); death (861); unknown status at follow-up (601) (Wooldridge et al. 1986); in the hospital at six months and living in the community less than two weeks (15); in a nursing home at six months and living in the community less than two weeks (78); missing baseline data on satisfaction with care (1,477); missing data on the twelve-month nursing home utilization outcome (303); and missing data on other variables in analysis (163).
4. It is possible that this technique may not have detected nonrandom elimination of observations, but it is the best test we are aware of. Further, the trade-off here was to exclude patient satisfaction, which was problematic since it was a significant factor in each of the nursing home utilization estimations and contributed directly or indirectly, or both, to each nursing home utilization outcome. Had this important variable been omitted from nursing home utilization estimations, the model would not have been fully specified, and specification bias would have been a potential threat to the validity of study findings.
5. Supplementary analyses were performed using maximum likelihood estimation (MLE) techniques to compare results with and without observations having missing data on the baseline satisfaction measure ( $n = 3,347$  and 2,109, respectively). For the estimations involving 3,347 study participants, mean values were substituted for missing values on the baseline satisfaction indicator and a dummy variable also was incorporated into the analyses. The magnitude, direction, and significance of the effects of Channeling on home care and subsequent nursing home utilization were the same in both sets of estimations. Similarly, the magnitude, direction, and significance of the effect of home care on the probability of subsequent nursing home utilization was the same with and without the additional observations for estimates of the total number (log) of nursing home days and the probability of still residing in a nursing home. For the estimation of the probability of still residing in a nursing home at twelve

months, the effect of home care on subsequent nursing home utilization was both positive and significant in the smaller sample ( $n = 2,109$ ) but it became positive and insignificant in the larger sample ( $n = 3,347$ ). Since the overall results were the same with and without the additional observations, and since significant theoretical and methodological problems may arise when substituting mean values for missing data (Bollen 1989, 370-73), the final estimates reported in this study were (a) obtained with the use of WLS estimation techniques and (b) based only on those subjects having complete information on all variables in the model.

6. Similar client characteristics were reported for the full study sample (Carcagno et al. 1986).
7. Results were also compared with findings from maximum likelihood estimation, as well as from two-stage logistic and two-stage probit techniques. While the magnitude and directionality of effects were quite similar across estimation methods, the standard errors were generally smaller under WLS.
8. Since the  $\log(0)$  is undefined, values of zero are generally converted into a small fraction to enable the logarithmic transformation to take place. In this analysis, the  $\log(0)$  was redefined as  $\log(0.1)$ .
9. Total effects were also calculated by those initially investigating Channeling, but different control variables were included in these reduced-form analyses, different methods were utilized, and different samples were studied (Kemper 1988; Corson et al. 1986; Wooldridge and Schore 1988). The total effects for the Basic Model and the Financial Control Model were consistent with those reported by Wooldridge and Schore.
10. The effects depicted in Figure 2 have been transformed into their natural (not logarithmic) units.

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