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Determinants of Adherence to Medical Regimens by Hypertensive Patients

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This study employed multivariate analyses and structural modeling procedures to examine a model for the determinants of adherence to medical regimens. Fifty adult hypertensive patients at a health maintenance organization completed questionnaires and participated in home interviews over a 10-week period. Knowledge of medical regimens, information communication between the patient and the medical professionals, satisfaction with health-care providers, health locus of control, social support, and treatment disruption to life-style were assessed. Adherence was assessed through self-report and behavioral (i.e., pill-count ratio, percentage of kept medical appointments) indices. Finally, repeated blood-pressure measurements were obtained. Structural modeling procedures revealed that greater expectancy for internal control over health and hypertension, greater knowledge of the treatment regimen, and stronger social support were significant determinants of adherence; in turn, higher levels of adherence facilitated blood-pressure reduction.

KEY WORDS: Adherence; compliance; hypertension; medical regimens; blood pressure.

INTRODUCTION

According to a report by the Surgeon General (U.S. Department of Health, Education, and Welfare, 1979), "of the 10 leading causes of death

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in the United States, at least seven could be substantially reduced if persons at risk improved just five habits: diet, smoking, lack of exercise, alcohol abuse, and use of antihypertensive medication" (p. 14). Despite encouragement by medical professionals to improve personal habits such as these, many health-care recipients engage in potentially life-threatening behaviors. Adherence to health-care regimens, defined by Haynes *et al.* (1979) as "the extent to which a person's behavior (in terms of taking medications, following diets, or executing lifestyle changes) coincides with medical or health advice" (p. xv), is thus a critical issue for the health-care system and its recipients (Sackett and Snow, 1979). The estimated proportion of individuals who fail to comply with health-related recommendations ranges from 15 to 94% (Davis, 1966), and patients with chronic, lanthanic conditions, such as essential hypertension, are particularly at risk for nonadherence (Sackett and Snow, 1979).

The specific consequences of nonadherence may range from the negation of gains arising from treatment to the implementation of unnecessary diagnostic and therapeutic procedures, with resultant increased health-care expenditures. A cost-benefit analysis (Weinstein and Stason, 1976) suggested that funds provided for bolstering hypertension treatment compliance would better serve to decrease death and disability than would the same resources used for identifying and treating new cases.

Given the broad scope and severe consequences of nonadherence, ever-increasing attention has been devoted to identifying factors which contribute to compliance. Thus far, the majority of studies in this area has examined the relationship of a singularly indexed adherence variable to one or two hypothetically related constructs. Unfortunately, as Caplan *et al.* (1976) point out, a review of this voluminous literature leaves one with the impression that "there are a lot of bones but the picture of the skeleton remains evasive" (p. 19).

In order to obtain a more complete and veridical picture of adherence, researchers (e.g., Becker and Maiman, 1975; Caplan *et al.*, 1980; Leventhal *et al.*, 1984) have begun to integrate empirical findings into conceptual models. Drawing from a synthesis of the adherence literature, this study developed and tested such a model (see Fig. 1). Here, relationships among factors postulated to determine adherence, actual adherence, and health outcome are displayed. Causal paths, depicted as unidirectional arrows, are drawn from variables intended as causes to those intended as effects. Paths are labeled with lowercase letters.

A number of specific hypotheses follow from the path diagram. Paths a through d represent predictions based on reviews (e.g., Garrity, 1981; Hulka, 1979; Masur, 1981) emphasizing the importance of the quality of patient–provider communication in promoting adherence. A primary aspect of this communication is the success with which the provider conveys relevant

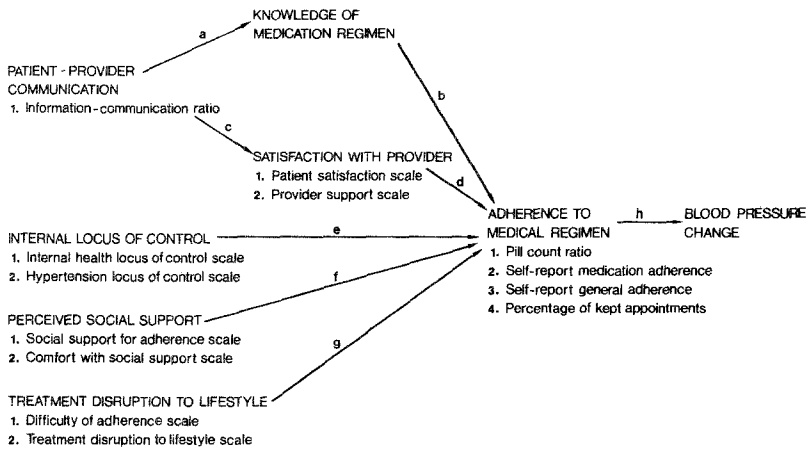


Fig. 1. Hypothesized structural model for the determinants of adherence. Measures employed as indicators of each construct are listed under the construct heading.

information to the patient (Ley, 1977). The resultant accuracy with which the recipient can recall the provider's advice (path a) is postulated to be a necessary condition (path b) for adherence (Kirscht and Rosenstock, 1979). A second aspect of patient-provider communication is its emotional impact, which can be conceptualized as the patient's satisfaction with the care provider. Haynes (1976) concluded in his literature review that a significant positive relationship exists between satisfaction with specific components of medical care and adherence. In the proposed model, it was hypothesized that successful communication of information would increase the patient's satisfaction with the provider (path c), which would in turn promote adherence (path d).

Overall, patients' attitudes regarding *general* health matters have not been found to relate to compliance (Becker, 1979). A potential exception is found in health locus of control, a construct which refers to one's expectancy for control (internal) or lack of control (external) over health. Internal health locus of control has been found to relate to compliance (e.g., Cromwell *et al.*, 1977). Similarly, an association between expectancy for control of a specific disease and adherence was demonstrated by Witenberg *et al.* (1983). Path e reflects the postulated contribution of such internal expectancies to adherence.

Path f depicts the hypothesis that social support from significant others would facilitate adherence. Caplan *et al.* (1980) found that adherence to an antihypertensive regimen was associated with the amount of affective support provided by others, and several reviews (e.g., Becker, 1979) have pointed to the importance of social support.

The degree to which the patient perceives a treatment protocol as disruptive to his or her life-style has been conceptualized by researchers interested in the Health Belief Model (see Janz and Becker, 1984) as a potential "cost" which influences adherence decisions. Path g reflects the conclusion of reviewers (Haynes, 1976; Masur, 1981) that the more a regimen is perceived to require modification of daily routine, the less likely one is to comply. Finally, it was predicted (path h) that adherence would promote blood-pressure reduction.

In order to evaluate this model, postulated contributors to adherence were associated with adherence and blood-pressure change. Where possible, multiple construct indicators were employed. Further, as suggested by Epstein and Cluss (1982), adherence and health outcome may be related but are not synonymous. Thus, in contrast to many previous studies, the association of adherence and blood pressure was examined. Multivariate analysis of variance was employed to assess differences between relatively adherent and nonadherent patients on the above-mentioned variables. Covariance structure analysis was also performed to provide an evaluation of postulated relationships among the constructs. Because it is recommended that structural modeling be performed on large subject samples, results from this analysis based on data from 50 patients must be interpreted cautiously.

METHOD

Subjects and Procedures

The investigation was conducted at a health maintenance organization (HMO), which primarily serves employee groups through prepaid medical plans. The participating medical professionals were three physicians and four registered nurses from the internal medicine division. Two other physicians declined participation. The providers were informed that the research would examine adherence, but they were not told of the specific variables under study.

Patients recruited for the study were drawn from ambulatory adult hypertensive patients who had been under care in the internal medicine division for no longer than 1 year. A computer listing of those patients taking medications for hypertension was generated and yielded 116 eligible patients. Over the duration of the study, care providers received lists of their eligible patients who had appointments scheduled during the following week. At each such appointment, the provider explained the project, presenting the study's purpose as an attempt to enhance health care, and assessed the patient's willingness to participate. After each meeting, the provider completed a questionnaire regarding provision of information to the patient.

Within a week after each patient's appointment, potential participants were contacted by telephone, and the study was described. Patients were assured that the HMO personnel would not learn of their specific responses. Fifty adults agreed to participate in the investigation. Of the 116 eligible patients, 73 had appointments over the study's duration. Of these, 58 patients were referred to the project, and 8 subsequently declined participation. Fifteen patients who had appointments were not referred to the project.

With regard to descriptive characteristics of the 50 participants, the average hypertensive patient was 58 years old (range, 29–78 years), lived in a three-member household (range, zero to six members), and had a yearly family income of $12,000 to $15,000. Fifty-six percent of the patients were male, 76% were married, and 48% were employed outside the home, while 20% were homemakers and 32% were retired or disabled. Two of the patients were black, one was Hispanic, and 47 were white. Patients had carried a hypertension diagnosis for an average of 8 years (range, 2–336 months) and had been visiting the clinic for almost 6 months (range, 0–12 months).

The 50 participants were sent questionnaire packets during the first and ninth weeks of participation which assessed the variables under study. Patient returned the first packet by mail within 1 week. The second packet was collected at a home interview conducted during the tenth week. Two female graduate students each interviewed 25 patients. Here, knowledge of the medication regimen and adherence were assessed, and the patient's blood pressure was taken. The measures postulated as construct indicators are listed in Fig. 1.

Measures

Patient–Provider Communication. These instruments, modeled after those developed by Hulka (1979), assessed the providers' success in communicating information about hypertension treatment. The providers and patients each indicated which topics had been discussed during treatment, and an information communication ratio was computed by dividing the number of topics which they agreed had been discussed by the sum of the number of items agreed upon and the number of items on which the patient and professional disagreed. Thus, the ratio potentially ranged from .00, indicating total disagreement between clinician and patient, to 1.00, indicating perfect correspondence.

Knowledge of Medication Regimen. This variable was assessed with questions employed by Caplan *et al.* (1980) regarding all medications taken by the patient. Answers to five questions regarding medication requirements for hypertension were compared with medical chart information and with the interviewer's examination of the patient's medication in order to deter-

mine the number of correct responses, with a score of five indicating perfect knowledge.

Satisfaction with Care Provider. Two scales assessed this construct. The Patient Satisfaction Scale was developed by Ware *et al.* (1978) and modified by Howe (1981). It contains 11 items which reflect satisfaction with the professional's warmth, technical competence, and willingness to share information. An internal consistency estimate of reliability, the coefficient alpha (Cronbach, 1951) obtained in this study was .83. The second questionnaire was adapted from Caplan *et al.* (1980). This eight-item Provider Support Scale assessed emotional support provided to the patient and had a coefficient alpha of .95. The correlation between the two scales was .57.

Locus of Control Scales. The first scale employed was the Internal subscale from the Multidimensional Health Locus of Control Scale developed by Wallston *et al.* (1978). Assessing patients' general expectancies for control over their own health, this scale possesses adequate test–retest reliability and discriminant and concurrent validity. The coefficient alpha obtained in this study was .90.

The Hypertension Locus of Control Scale, modeled after questions employed by Witenberg *et al.* (1983) in a study of renal dialysands, assessed expectancies for personal control of hypertension outcome. This four-item scale in a 7-point Likert format achieved a coefficient alpha of .87 and had a correlation of .76 with the previous scale.

Perceived Social Support. Two instruments, the Social Support for Adherence and Comfort with Social Support Scales, were administered. The first, modeled after Caplan *et al.* (1980), was a five-item scale in a 5-point Likert format. It assessed tangible and affective support offered by the individuals, excluding medical personnel, who were most helpful to patients in caring for their disease. A coefficient alpha of .75 was obtained for this device. The second instrument was a single 5-point item assessing the patient's comfort with the help offered by the supportive other. These two scales correlated at .67.

Treatment Disruption to Life-Style. The first scale employed, Difficulty of Adherence, included seven items in a 5-point Likert format modified from Caplan *et al.* (1980) to assess a broader range of adherence activities. The coefficient alpha for this scale was .72. The second scale, Treatment Disruption to Life-Style, was a three-item scale in a 7-point Likert format constructed to assess the resultant disruption to life habits of three types of medical regimens: medication, dietary, and physical exercise. Achieving a coefficient alpha of .68, it correlated .65 with the first scale. Both scales were scored such that a relatively high score indicated greater life-style disruption.

Social Desirability. This variable was assessed with a short form of the Marlowe–Crowne Social Desirability Scale (Strahan and Gerbasi, 1972), a

10-item scale which obtained internal consistency reliabilities that ranged from .59 to .70 in the 1972 study.

Measures of Adherence. Four measures served as indicators of adherence. The first, Self-Report Medication Adherence, assessed the frequency of missing medications in various circumstances and was adapted from Caplan *et al.* (1980). This nine-item scale in a 5-point Likert format had a coefficient alpha of .90. The second scale, Self-Report General Adherence, was also adapted from Caplan *et al.* and assessed compliance with the general medical protocol. With seven items in a 5-point Likert format, its internal consistency reliability was .84. Higher scores on these scales indicated greater adherence.

Two behavioral indicators of adherence were recorded. The first, Percentage of Kept Appointments, was calculated from the patient's medical chart, which noted kept and failed appointments from the time that the patient first entered the internal medical service to the study completion. Finally, a pill-count ratio was computed by dividing the number of pills which the patient actually took by the number of pills which the patient should have taken according to medication schedules. This measure was calculated by first subtracting the number of pills remaining in the patient's medication bottles at the home interview from the total number of pills prescribed as indicated by a computer listing of HMO pharmacy prescription records. This yielded the number of pills which the patient actually took. The result was then divided by the number of pills the patient should have taken, as calculated from the patient's medical chart. These ratios were obtained for all current prescriptions from the day that the medication was first prescribed and potentially ranged from .00, indicating total nonadherence, to 1.00, suggesting perfect compliance.

Blood-Pressure Measurement. Blood-pressure readings were taken at the time of referral to the study and at the home interview. The initial readings were taken by medical professionals using a mercury sphygmomanometer. Only the sitting blood pressure was recorded. If multiple readings were taken, the final reading was chosen for the purpose of statistical analyses.

At the home interview, the patient's sitting blood pressure was taken at the session's midpoint and again at the visit's conclusion. A hand-held electronic sphygmomanometer was employed. This instrument previously had been demonstrated to yield readings which corresponded to those of a mercury sphygmomanometer within ± 2 mm Hg across the range of pressure readings. The two interview readings yielded correlations of .82 for systolic and .83 for diastolic blood pressure. The final reading was selected for inclusion in statistical analyses.

In view of the variable nature of blood pressure, one may question the representativeness of readings taken at only two points in time. To address

this issue, correlations were calculated between readings taken at medical appointments occurring within 4 weeks of the referral appointment ($n = 39$) or of the home interview ($n = 36$). For both systolic and diastolic blood pressure, correlations ranged from .73 to .75, suggesting that the readings employed in the present analyses were at least moderately representative of blood pressure over a circumscribed time span.

RESULTS

The results are presented in three sections. First are the multivariate comparisons between adherent and nonadherent groups. Next, the measurement and causal models for the determinants of adherence are presented. Finally, factors that may affect the internal validity and generalizability of the obtained outcomes are considered.

Comparison of Relatively Adherent and Nonadherent Groups

The literature regarding hypertension has demonstrated that patients must take at least 80% of the prescribed medication in order to obtain maximum therapeutic benefit (Sackett *et al.*, 1976). Thus, we have a logical basis for dichotomizing the patients into adherent and nonadherent subject groups. The hypertensive subject sample was divided into those who had taken 80% or more of their medications ($n = 27$) and those who were less than 80% adherent ($n = 23$), as measured by the pill-count ratio. Six multivariate analyses of variance were performed to evaluate group differences on sets of measures postulated to reflect each construct, followed by univariate analyses when the multivariate Wilks' criterion F was significant. Univariate analyses were performed on the constructs assessed by a single indicator. Table I displays the results of these analyses.

A profile of the average adherent and nonadherent subject emerges from these comparisons. Diastolic blood pressure remained virtually unchanged for adherent subjects, while it increased for nonadherent subjects. Systolic blood pressure evidenced a similar although nonsignificant tendency, with a decrease for adherent patients and an increase for less compliant subjects. Both behavioral and self-report adherence indicators were substantially higher in the adherent group.

With regard to the hypothesized determinants of adherence, all comparisons were in the expected directions and most were highly significant. Thus, as compared with noncompliant patients, there was a tendency for adherent subjects to agree with their providers regarding which topics pertinent to hypertension were discussed during their appointments. Adherent

Table I. Comparison of Adherent (n = 27) and Nonadherent (n = 23) Groups[a]

Construct and measures	F	Proportion of accounted-for variance	Adherent group		Nonadherent group	
			M	SD	M	SD
Blood-pressure change[b]	5.33*	.18				
Systolic BP	2.64	.05	2.07	17.10	−6.39	19.74
Diastolic BP	10.88**	.18	−.52	12.64	−10.57	7.91
Adherence	10.82***	.41				
Self-report medication	27.18***	.31	41.78	5.02	32.61	7.35
Self-report general	15.45***	.24	27.74	3.60	22.04	6.44
% kept appointments	8.45*	.15	98.33	4.11	90.78	12.76
Satisfaction with provider	3.63*	.13				
Provider support	7.04*	.13	32.89	6.95	26.91	8.96
Patient satisfaction	3.68	.07	45.56	5.28	42.52	5.91
Locus of control	8.85***	.27				
Health locus of control	10.04**	.17	26.22	6.80	19.48	8.25
Hypertension locus of control	18.02***	.27	22.70	2.76	16.17	7.43
Perceived social support	5.41*	.22				
Social support for adherence	10.88**	.22	20.05	4.65	15.47	4.14
Comfort with social support	5.60*	.13	4.36	1.05	3.59	1.07
Treatment disruption to life-style	9.66***	.29				
Difficulty of adherence	8.95**	.16	18.48	3.26	23.87	5.30
Treatment disruption	19.33***	.29	5.37	2.88	8.22	3.84
Information communication ratio	2.23	.04	.53	.19	.45	.20
Regimen knowledge	22.58***	.32	4.00	1.04	2.22	1.59

[a]Multivariate F values were calculated on 2,47 df, with the exception of the F for the adherence variables, which was calculated on 3,46 df. Univariate F values were calculated on 1,48 df. The proportion of accounted-for variance was determined from the R^2 associated with the univariate analyses of variance and from $(1 - \Lambda)$ associated with the multivariate analyses.

[b]Blood-pressure change = referral blood pressure − interview blood pressure.

*$p < .05$.
**$p < .005$.
***$p < .0005$.

Table II. Measurement Model for Latent Constructs

Construct	Indicator	Factor loading	Error
Patient-provider Communication	Information communication ratio	1.00	
Regimen knowledge	Knowledge of medication regimen	1.00	.61**.[a]
Satisfaction with provider	Patient satisfaction	.79***	.62***
	Provider support	.72***	.69***
Locus of control	Internal health locus of control	.83***	.59***
	Hypertension locus of control	.92***	.40*
Perceived social support	Social support for adherence	.85***	.53**
	Comfort with social support	.78***	.62***
Treatment disruption to life-style	Difficulty of adherence	.95***	.32
	Treatment disruption to life-style	.68***	.73***
Adherence to medical regimen	Self-report medication adherence	.95***	.31
	Pill-count ratio	.50***	.87***
Blood-pressure change	Diastolic BP change (referral-interview)	1.00	

[a]Disturbance correlated with pill count.
*$p < .05$.
**$p < .01$.
***$p < .005$.

patients also possessed more knowledge of their medication regimens. They tended to report greater satisfaction with their providers and rated them as more supportive than did noncompliant patients. Further, adherent patients reported feeling greater support from others and expressed more comfort with that support. Finally, they expected to have more control over health and hypertension and regarded their regimens as less disruptive to their life-styles.

A Structural Model for Adherence

The design of this study afforded the opportunity to test an a priori causal model of adherence. Structural modeling generally involves two types of analyses. First, a confirmatory factor analysis is employed to determine whether the measures postulated as indicators of particular constructs do in fact reflect those dimensions. Next, a structural equation model is developed and tested. Here, causal relationships among latent variables (i.e.,

hypothetical constructs) are specified and the causal effects are evaluated using path analytic techniques. All analyses were performed using the LISREL VI computer program (Jöreskog and Sörbom, 1983).

Variables included in the measurement and structural models were chosen prior to the application of structural modeling techniques on the basis of rational and empirical considerations. First, self-reported medication adherence and the pill-count ratio were selected for inclusion as the adherence indicators. These were the measures that represented a specific adherence construct: compliance with the *medication* regimen. Second, diastolic blood-pressure change was selected as an endogenous variable. Finally, with the exception of patient–provider communication and regimen knowledge, other constructs were represented by two measures.

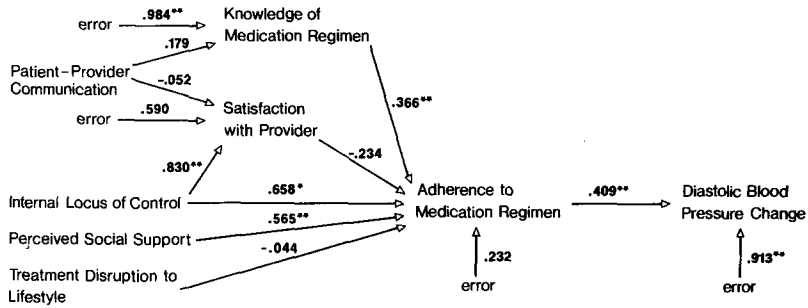
The Adherence Measurement Model. In the measurement model, paths from the latent constructs to the corresponding indicators can be viewed as factor loadings. These loadings and associated error terms are displayed in Table II. Constructs with single indicators are assumed to be measured without error and thus carry factor loadings of 1.00. In the present model, factor loadings for indicators of other latent constructs ranged from .498 to .950, and all were significant at the $p < .005$ level. It should be noted that the errors of the pill-count ratio and regimen knowledge are assumed to be correlated. An inspection of the measurement model without correlated errors indicated that the residual resulting from these two variables was comparatively large. Correlated errors could be postulated because the two measures share a common method; that is, both are objective measures.

The hypothesis that the measures are indicators of their respective constructs was tested through a comparison of the obtained correlations among variables and the correlations expected from the specified measurement model. Such a comparison yields a χ^2 for "goodness of fit," with a nonsignificant χ^2 indicating a good correspondence between the observed and the expected correlations. With 39 degrees of freedom, the χ^2 for the current model was 45.36 ($p = .224$). The normed fit index (Bentler and Bonett, 1980) obtained for this model was .87 and the root mean square residual was .064. These results support the conclusion that the indicators did in fact reflect the hypothesized constructs.

The Structural Equation Model for Adherence. Having support for the adequacy of the measurement structure, we can examine the hypothesized structural model. For the model depicted in Fig. 1, the test for goodness of fit was significant [χ^2 (52) = 82.86, $p < .005$], indicating less than optimal correspondence between obtained and expected correlations. This suggested that the model was misspecified; that, in this case, too few causal paths were hypothesized. The results from the model were examined, and a large modification index was found for satisfaction with the professional and locus

of control, suggesting misspecification for those constructs. Thus, an additional causal path was hypothesized; that is, it was predicted that an internal locus of control for health would bolster ratings of satisfaction with the medical professional. This hypothesis is conceptually reasonable when one takes into account both the finding that "internal" patients were found to be relatively dissatisfied with low provision of information on hospital wards (Seeman and Evans, 1962) and the observation that the orientation for health care at the HMO is one which advocates patient education and preventive provision of information. Thus, we may speculate that those patients with more internal expectancies would be more satisfied with such health care. For the revised model, the test for goodness of fit between expected and observed correlations was nonsignificant [χ^2 (51) = 62.34, p = .13], the normed fit index was .82, and the root mean square residual was .089. Thus, this model, which is displayed in Fig. 2, achieved a closer correspondence between obtained and predicted correlations than the original postulated model.

In order to evaluate the causal contribution of each construct to adherence, each path coefficient was examined. These path coefficients are analogous to regression beta weights. As Fig. 2 demonstrates, internal locus of control was found to facilitate satisfaction with the health-care provider. High knowledge of the treatment regimen, internal locus of control for both general health and hypertension, and strong social support with which the patient was comfortable served to facilitate proper medication adherence. The indirect effect of patient–provider information communication mediated through satisfaction with the provider and the direct effect of treatment disruption to life-style on adherence were not borne out. Adherence was demonstrated to be a significant mediator for the patient characteristic variables on diastolic blood-pressure change.



*p < .05. **p < .01.

Fig. 2. Revised structural equation model for the determinants of adherence.

Factors Influencing Obtained Outcomes

Several issues arise which may influence interpretation of the previous results. The first of these concerns interviewer effects. The home interviewers may have differentially affected responding on the adherence variables, regimen knowledge, and blood-pressure readings. Mean difference tests by interviewer on these variables did not approach significance, however.

Whether or not patients responded in a socially desirable direction comprises the second issue. Accordingly, all measures were correlated with scores on the social desirability measure. The 13 correlations ranged from $-.35$ to .08. Only one was significant ($r = -.35, p < .05$), such that as the internal locus of control for hypertension increased, the tendency to respond in a socially desirable manner decreased. This correlation was in the opposite direction from one which would be of concern in the interpretation of results. Thus, the influence of social desirability did not threaten the internal validity of obtained outcomes.

The third issue involves the effect of objective complexity of the patient's medical regimen on adherence. Because of the assumption that one's perception of life-style disruption may be more important in affecting adherence than actual disruption, the former variable was chosen for inclusion in the model. However, the ability to rule out objective disruption as a primary contributor to adherence may strengthen confidence in the present model. Accordingly, an index (Caplan *et al.*, 1980) of objective regimen complexity was derived, taking into account the number of antihypertensive medications prescribed, number of different medication schedules, maximum times per day medications were taken, and total number of pills taken per day. In preliminary analyses, this index was found to be significantly associated only with the percentage of kept appointments, indicating that patients with more complex regimens were less likely to keep appointments. Thus, regimen complexity did not appear to influence major variables in the model.

The fourth issue involves the representative nature of the hypertensive subject sample. Of primary interest were the differences between the final subject sample and all other eligible hypertensive patients. Patients in the final subject sample had higher systolic blood pressures and tended toward higher diastolic blood-pressure readings than patients who had no HMO contact during the study. They also took a greater number of medications and had more frequent scheduled appointments. Similarly, participating subjects had higher systolic and diastolic blood pressures than those who had medical appointments but were not referred. No differences were obtained between variables for subjects completing the study and those refusing participation. These results converge to suggest the possibility that participating subjects

were more unhealthy than nonparticipants, perhaps stemming from greater noncompliance. These findings may limit the generalizability of the results to patients at the greatest risk for negative health consequences but simultaneously increase their relevance for similarly debilitated adults.

A second issue regarding generalizability involves the amount of time that the patient sample had been treated for hypertension at the HMO. Of the 21 correlations computed between the duration of treatment and patient characteristic, blood-pressure, and adherence variables, only 2 were significant. First, it was found that the longer patients had received treatment at the HMO, the lower the systolic blood pressure they manifested. Second, patients became more comfortable with outside social support as HMO treatment progressed.

When the duration of hypertension diagnosis was included as an additional factor in preliminary multivariate analyses of variance, the only significant finding that emerged suggested that patients who had been diagnosed hypertensive for a longer time evidenced less correspondence with their providers in communicating information. Considering the demonstration in other studies that as the time since diagnosis increases, adherence decreases, it is surprising that these analyses did not yield other significant findings. Perhaps the fact that patients had been in treatment at the HMO for a relatively brief time served to lessen the impact of diagnosis duration on adherence.

Finally, because research (e.g., Laughlin *et al.*, 1980) has suggested that home blood-pressure readings may be lower than clinic readings, differences obtained in the present study between clinic and home readings might be biased toward improvement in blood pressure. If this potential bias remains relatively stable across subjects, then relationships between blood-pressure change and other variables should not be affected, however.

DISCUSSION

In the present study, a model regarding the determinants of adherence was developed and derivative hypotheses were examined. Multiple measures from self-report and behavioral domains were employed. First, comparisons were made between relatively adherent and nonadherent patients on the variables of interest. In general, group differences were in the direction suggested by the hypothesized causal model.

Specification and testing of a model for multiple determinants of medical regimen adherence were also performed. With one revision, the obtained relationships among construct were not significantly different from the relationships that one would expect, given the postulated structural model. Internal locus of control for health and hypertension, knowledge of the

medication regimen, and perceived social support were significant contributors to regimen adherence, which in turn facilitated diastolic blood-pressure change. In addition, expectancies for internal control positively affected satisfaction with the health-care provider. The postulated contributions of treatment disruption, satisfaction with provider, and patient–provider interaction to adherence were not borne out.

Some discusssion of hypotheses within the structural model which failed to receive support is warranted. The contribution of perceived treatment disruption to nonadherence was suggested by both the previous literature and the analyses of adherent and nonadherent groups in this study. In this model, adherence was specific to the medication regimen, while treatment disruption was assessed in relation to the broader medical regimen. Two possibilities arise. First, treatment disruption may not hinder adherence to the medication protocol, as the difficulty in taking medications may be less than that engendered by regimens which require more complex behaviors, such as dietary recommendations. Second, if only measures which assessed disruption arising from the medication regimen had been employed in the model, the predicted association may have been obtained.

Satisfaction with the provider also did not yield a consistent positive association to adherence. It may be that satisfaction with specific aspects of provider behavior (e.g., technical competence, emotional support) are salient contributors to patient adherence at specific stages of the provider–patient relationship. Research with a multidimensional satisfaction measure, such as that developed by Wolf *et al.* (1978), may serve to elucidate such a possibility.

Finally, all analyses converged to suggest that agreement between the patient and the provider regarding provision of information did not significantly facilitate adherence. This was an indirect measure of the patient–provider interaction which measured only one aspect of the relationship. More sophisticated assessment devices for this construct may have yielded more promising outcomes. We now turn to a consideration of the heuristic value of the present study.

Identification by the medical professional of parameters signaling patient nonadherence comprises an initial area of potential heuristic value. First, if blood pressure remains inadequately controlled over a course of treatment, professionals need not act on an automatic assumption that the therapeutic protocol is in error. Rather, nonadherence to the existing regimen may be the problem. Direct measures of adherence may be used to evaluate this possibility. The percentage of appointments kept by the patient also may prove to be an accurate, although relatively unobtrusive indicant. Several attributes manifested by the patient may also signal noncompliance, such as a lack of regimen knowledge, little social support from significant others, and a lack of internal locus of control for health.

Successful identification of the nonadherent patient is a necessary precursor to amelioration of such lack of cooperation. The several means for bolstering adherence have been recently reviewed (e.g., Becker and Maiman, 1980; Epstein and Cluss, 1982; Haynes, 1979; Masur, 1981). It is likely that interventions directed toward enhancing adherence will need to be maintained as long as compliance is required, unless effective maintenance strategies can be developed. Whether a multidimensional approach to the enhancement of adherence or one in which treatment is tailored to the client following a thorough assessment will prove more efficacious awaits continued study.

Indeed, the greatest potential value of the present research lies in its ability to stimulate further investigation. First, refinement of the assessment devices may prove beneficial. Although results obtained from assessment of internal consistency and confirmatory factor analysis provided support for the psychometric adequacy of measures administered, collection of additional reliability and validity data is warranted. Second, a 10-week period allowed for only one administration of measures, thus preventing analysis of the reciprocal relationships suggested by Caplan *et al.* (1980) and providing an admittedly circumscribed look at blood-pressure change. Increased confidence in this model's validity requires examination over a longer time span. It is also important to assess the generalizability of the results obtained to hypertensive patients in other settings and to other subject populations, such as newly diagnosed hypertensives. Further, adherence to antihypertensive regimens may be engendered by a different set of determinants than adherence to treatment protocols for other disorders. The generalizability of these results to acute conditions, to chronic apparently debilitating disorders, and to other chronic lanthanic diseases awaits investigation.

The empirical support for the present model does not imply that other models could not have produced equally as good or better results. The present model needs to be compared with other models in order to substantiate its efficacy. Such empirical verification of conceptual models for adherence may suggest new directions for productive intervention strategies, which in turn require validation.

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