

In Brief

Improved health outcomes for individuals with diabetes depend on integrating self-management into daily life. A wide variety of educational, behavioral, and affective interventions are available that individually produce modest improvements in patient adherence to treatment recommendations in diabetes and related chronic illnesses and that work somewhat better when used in combination. A summary of selected successful interventions is presented.

Improving Adherence to Diabetes Self-Management Recommendations

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Diabetes is one of the chronic illnesses for which self-management plays a central role in care. In this regard, it is similar to hypertension or congestive heart failure but quite different from some other chronic illnesses such as breast cancer.

To optimize their health, individuals with diabetes may be advised regarding diet and exercise, frequent medical examinations, annual specialized examinations of their eyes and feet, and, for many, prescribed multiple oral or injected medications every day. Until there is a cure for diabetes, these behaviors must be sustained for a lifetime.

Matters are made more complicated by the high prevalence of comorbidity among adults with diabetes: they are at increased risk of hypertension and lipid disorders. These conditions may require still more medical management, which must be integrated with the treatment of diabetes itself. For those unfortunate enough to develop the vascular complications of diabetes, still more demands of self-management are imposed.

Managing one's diabetes is a complex task that touches nearly every important aspect of daily life, and we providers might marvel that any individual manages to do it at all. Success requires an alliance between patients and their health care providers, one or more from a team including physi-

cians, nurses, dietitians, diabetes educators, pharmacists, and other specialized health professionals. In the current organization of health care it falls to primary care providers to monitor patients' biological progress and prescribe an appropriately tailored treatment plan. Much of the difficult work of supporting and facilitating patients' implementation of these complex plans (i.e., self-management education, behavior change choices) is delegated to other members of the team or not done at all.

It is worth noting, of course, that discrepancies between treatment recommendations and patient self-management are not the only cause of poor diabetes outcomes: providers' prescriptions and the advice of other health professionals do not always draw on the full base of knowledge about treating diabetes. Whereas guidelines for treatment of hypertension¹ have been set out in algorithmic detail, the more fluid evidence-based guidelines for treatment of diabetes may contribute to provider deviations from best practices. In addition, the multiple variables to be considered in diabetes management increase the complexity of the task. Health care systems may place additional barriers in the way of bringing what we know about diabetes to bear on the care of their patients. But systems design and provider adherence to guidelines are

topics worthy of extensive separate treatment and are not dealt with here.

We focus instead on what can be done to ensure that patients are given the opportunity to consider, adopt, and maintain the central tasks of diabetes self-management: practicing healthy lifestyle behaviors related to nutrition and exercise, taking medications as prescribed, self-monitoring glucose, and seeking medical care as appropriate. The goal of this article is to provide a useful summary for practitioners: we will refer to methodological issues only to the extent that they organize and clarify the presentation. We make recommendations for practice, but not for the research agenda. We will not emphasize logistical interventions such as providing transportation or mobile services, which are often not feasible in usual clinical settings.

Our review will touch on several areas: who is not likely to adopt self-management recommendations, how adherence can be assessed in clinical settings, and what steps have been demonstrated effective at improving adherence. It is interesting to note that this literature does not generally report whether subjects have made informed choices regarding the behaviors in question.

Although we appreciate the origin of Haynes² definition of “compliance” as the extent to which a patient’s actual behavior conforms to the advice dispensed by the health care provider, we also subscribe to the philosophy that individuals should be given the opportunity to make informed choices about their lifestyle and health care.³ We try to use the term “patient adherence” in the context of patients’ choice to adopt and maintain health behaviors, although the research literature for adherence/compliance does not often share this context.

The body of research in this area is manageable. For example, a Medline search for clinical trials of interventions specifically to enhance or promote adherence to prescribed medications among patients with diabetes turns up only a few hundred studies. Much of what we know about improving adherence is, in fact, borrowed from closely related areas facing similar behavioral issues, namely hypertension and coronary artery disease.

Despite its modest size, the adherence literature can be confusing.

Studies appear to contradict each other, or findings appear to change with only minor differences in the described intervention or the population studied. Fortunately, two excellent meta-analyses^{4,5} and two excellent reviews^{6,7} have been carried out, from which a few simple conclusions have been drawn: 1) nearly any intervention that makes sense will be of some benefit, 2) the effects of any particular intervention are typically small, and 3) application of multiple interventions of different types is more effective than any single intervention.

How Do We Recognize the Need for Intervention?

The breadth of the gap between providers’ recommendations and those behaviors patients choose to adopt, observed in either research or clinical practice, depends in large part on how it is assessed; estimates range widely as a result. The most common clinical practice is probably to ask patients to estimate their own level of adherence with diet and medications. These self-reports typically provide overestimates of adherence for several reasons. First, they may rely on patients’ own interpretation or memory of what advice was given and, if accepted, how closely it has been followed. Second, patients may tend to report higher levels of adherence in order to please health care providers or avoid embarrassment. In addition, recall is often disproportionately influenced by the most recent events, whereas it has been shown that adherence increases in proximity to a health care appointment.⁸

Lower estimates of adherence are typically found when recall-independent behavioral measures are used, such as pill counts, food diaries completed contemporaneously with eating, and review of monitoring logs. Of course, it is possible that patients choose to discard pills or engage in other misleading behaviors when these methods are used, so there is still room for error. The accuracy of pill counts, for example, may be enhanced (with a better picture of adherence behaviors) when pill counts are carried out on an unannounced basis during the course of a home visit. But this method of appraising adherence would generally be too intrusive and too labor-consuming for clinical settings, besides perhaps jeopardizing the trust relationship between providers and

patients, unless specifically requested by patients.

Indirect measurement of adherence can sometimes be accomplished through biological measurements: drug or metabolite levels in body tissues, weight gain or loss, assays for inert tracers incorporated into compounded medications, or nutrient components of foods. It should be remembered, though, that there is substantial biological variability among people in the drug levels that will be achieved with the same level of medication ingestion or the amount of weight that will be lost with a given degree of dietary restraint. And, like recall-based reports, the results of these measurements are typically most influenced by recent behaviors, thereby missing the greater degree of gaps in adherence that occur in days more remote from health care appointments. Their cost and discomfort also relegate these methods largely to research settings.

More recently, electronic devices to measure medication adherence have become available. These have not attained a significant role in the management of adherence in clinical settings at this time, and we do not discuss them here.

In short, there are serious methodological problems with the most common methods of measuring adherence. It is not surprising that published estimates of adherence range from very low to very high. It is probably best to consider all such estimates suspect and to remain agnostic about the extent of the challenges to adherence in various self-management behaviors for diabetes.

One area in which research is quite clear, however, is that there are very few characteristics that identify patients at high risk for gaps in adherence to recommendations.⁶ Neither sociodemographic characteristics nor aspects of personality predict treatment adherence. With the exception of relatively uncommon states such as mental illness (particularly paranoid thinking)² and transient periods of social instability^{9,10} (e.g., recent divorce, loss of job), no useful risk factors have been identified. Dunbar-Jacob et al.⁶ juxtaposing the results of Morrell et al.¹¹ and Park et al.¹², have suggested that older age improves adherence, and cognitive impairment is associated with lesser adherence. But in practice, cognitive impairment increases with advancing age so that

these two effects tend to cancel each other out, making each of little use in identifying patients at risk. Indeed, the conclusion of the literature is quite the opposite: the risk of adherence issues/gaps is essentially the same in all types of patients.

If attempts to identify people at risk for low adherence to recommendations have been largely fruitless, other approaches to targeting efforts at improving adherence may be useful. Adherence has been found to occur at very low rates early in the course of new treatments. Dropout rates from treatment for hypertension, cardiac rehabilitation, and smoking cessation are all high initially and then decline.¹³⁻¹⁵ Furthermore, early adherence is a good predictor of sustained adherence later on.¹⁶ Common sense then suggests that concentrating on identifying and improving adherence at the start of a regimen has greater potential for benefit than targeting old and new patients equally, although to our knowledge, this approach has not been tested in a clinical trial. Similarly, adherence is diminished by factors such as complexity of the treatment regimen, occurrence of side effects, and high treatment cost. While direct action to improve these aspects of a regimen is arguably the best approach, when circumstances do not permit this, these characteristics of the regimen can also be used to target efforts at adherence improvement to individuals at greatest risk.

If adherence is difficult to measure and high-risk subgroups are difficult to identify, how can we best target our efforts to improve adherence to those most in need of them? Haynes² has suggested three criteria to alert providers to a potential adherence problem:

1. Patients with a poor record of appointment-keeping are likely to have issues with other aspects of self-management as well. Fortunately, adherence with appointment-keeping is relatively simple to assess in most clinical settings.
2. Patients who do not respond to treatment, particularly to increasing intensity of treatment, in all probability are not adhering to treatment recommendations. Although nonresponse to increasing the dose of a drug might indicate that the particular drug is ineffective for the patient, when adding additional drugs or switching to new drugs of a different class does not bring about

improvement, an adherence issue is a likely cause.

3. The patients themselves may tell you if you ask them. Although patient self-reports of the extent of adherence are likely to be overestimates, Haynes asserts that a nonthreatening inquiry about self-management behaviors will yield answers with a sensitivity of 55% and a specificity of 87%. That is, 55% of patients who are not adhering will volunteer this information, and 87% of patients who are adhering will accurately affirm their status.

What Approaches to Improving Adherence Seem to Work?

In reviewing approaches to adherence, it is helpful to consider separately the aspects of adherence being improved and the type of intervention being considered. Haynes² and Roter et al.⁴ classify interventions into three similar categories (although they use slightly different labels for them): educational, behavioral, and affective.

Educational interventions seek to improve adherence by providing information and/or skills. The information may concern the nature of the disease, the array of diabetes self-management behaviors, and the positive and negative consequences of not adopting health recommendations. But at least as important is information about what to do if a dose of medication has been missed or if intercurrent illness or other problems arise or if you are traveling across many time zones.

Education may take the form of individual instruction or group classes. It might be provided in writing or through a visual medium such as videotape, multimedia computer software, or access to special Internet sites. In any event, a key element of successful educational strategies is providing simple, clear messages, hopefully tailored to the needs of the individual, and verifying that the messages have been understood.

Behavioral approaches have their roots in cognitive-behavioral psychology and use techniques such as reminders, memory aids, synchronizing therapeutic activities with routine life events (e.g., taking pills before you shower), goal-setting, self-monitoring, contracting, skill-building, and rewards. As with educational approaches, some of these approaches, such as skill building, may be pro-

vided individually or in groups and through a variety of media. For example, reminders may be mailed, e-mailed, or telephoned. What is important is that the behavior in question has been negotiated with and accepted by individual patients so that adoption of the behavior has a chance of succeeding in the long term.

Affective interventions seek to enhance adherence by providing emotional support and encouragement; recent diet and exercise intervention studies¹⁷ have used lifestyle “coaches” to help people adhere to the behavioral changes to which they have committed. Examples include rapport building through frequent telephone contact, home visits when feasible, family-based approaches (including family contracting), and interventions to enhance coping skills and self-efficacy.

The classification of interventions is important because, as Haynes says, “It is important to bear in mind that no single intervention has been shown to maintain long-term adherence; one must combine strategies from two or more of these three categories to achieve success.”² Roter et al.,⁴ in their more recent review of this area, draw a similar, if less boldly asserted, conclusion. What seems clear from a systematic review of studies of self-management training in type 2 diabetes¹⁸ is that it takes varying degrees of all three categories of intervention to have a positive impact on health or behavioral outcomes in diabetes; this possibly reflects the complex psychological landscape of self-management in a chronic disease such as diabetes.

In the remainder of this section, we identify specific interventions that appear to be effective in enhancing adherence with specific aspects of self-management. Because the effects of any particular intervention are usually small and because of methodological differences across studies, interventions listed here have not necessarily been found consistently effective. Nor is our list restricted to approaches that have been shown effective specifically in the management of diabetes. We include interventions, rather, when they have been found effective at least once and when they belong to a class of interventions that have been identified in a meta-analysis as having a significant effect on an adequate measure of adherence for treatment of chronic diseases.

Adherence with medications is affected by many things. It is generally agreed that simpler regimens such as once-a-day dosing are associated with better adherence than more complicated ones. Nevertheless, even with the simplest regimens, adherence can be poor.¹⁹ Numerous approaches have been used to improve adherence to prescribed medication regimens.

Table 1 presents selected interventions that have been found workable. What is striking is the diversity of personnel who can implement interventions successfully and the variety of technologies that can be used. It should also be noted that studies of interventions to improve medication adherence, both included and beyond those shown in the table, have focused on both prescription-filling and self-administration of the medication.

Physical activity plays a vital role in the self-management of type 2 diabetes. Exercise is the best predictor of maintaining weight loss, and, independent of weight loss, it decreases insulin resistance. Unfortunately, it is in the area of efforts to improve adherence with exercise recommendations that we have, perhaps, the smallest body of research. There are relatively few studies, and they tend to be small and brief. The most noteworthy findings are reviewed here.

Carlson et al.²⁰ sought not so much to increase adherence to exercise therapy among cardiovascular rehabilitation patients as to see whether it could be sustained using a less expensive program that de-emphasized electrocardiographic monitoring and allowed some of the sessions to be carried out

at home. They found, however, that the less expensive approach, perhaps because of its increased simplicity and lower cost, was associated with enhanced adherence.

In a study of exercise as a weight-loss treatment, Jakicic et al.²¹ found that women randomized to have access to home exercise equipment for short bouts of exercise were more adherent and lost more weight than those without access to exercise equipment. Mahler, Kulik, and Tarazi²² randomized patients being discharged after coronary artery bypass surgery to standard discharge information or to viewing of one of two educational videotapes. Both videotape recipient groups exhibited greater adherence with exercise recommendations, and those who viewed the tape portraying the post-discharge course as characterized by ups and downs were more adherent than the group whose tape portrayed it as steady progress. Annesi²³ found that a computerized feedback system that tracked progress, provided feedback, and set goals reduced dropout rates and delayed dropout from a prescribed exercise program carried out in a fitness center.

King et al.²⁴ studied the use of semi-weekly staff-initiated telephone contact as a supplement to baseline education to sustain participation in a home-based exercise program. They found the telephone intervention to result in both greater participation and improved fitness among those initiating the program and better maintenance of the behavior among long-term participants who had already

demonstrated improved fitness before randomization. In the maintenance phase of the study, they also found that daily self-monitoring was superior to weekly self-monitoring.

Jeffery et al.²⁵ found that obese men and women randomized to receive a personal trainer or financial incentives for participation in the exercise component of a behavioral weight-loss program achieved higher attendance levels than those randomized to usual treatment or usual treatment plus supervised walks. Notwithstanding this success, the increased attendance did not translate into increased energy consumption or greater weight loss.

The types of interventions used in these trials are similar to those used for improving adherence to other types of treatment. It is therefore reasonable to assume that similar generalizations about the increased effectiveness of multiple interventions, as established for other types of adherence behavior, will apply to exercise adherence as well.

Adherence to dietary recommendations to lower cholesterol and lose weight has been studied extensively in patients with or at risk for coronary heart disease. Dietary recommendations for these people are similar to those for patients with type 2 diabetes, so that similar interventions to improve adherence may be applicable.

Metz et al.²⁶ randomized 560 people with hypertension, diabetes, or lipid disorders to receive detailed dietary plans or prepared meals. They found that the group receiving prepared meals had better dietary adherence as measured by 3-day food diaries. While providing patients with meals is not a feasible intervention in most clinical settings, this study and others (e.g., the DASH trial²⁷) suggest that a market for meal provision for medical nutrition therapy might be developed. They also reinforce the notion that dietary adherence is very strongly influenced by the ready availability of healthy food choices and the unavailability of unhealthy ones.

From a more practical perspective, McCulloch et al.²⁸ found that practical lunch time demonstrations or videotape education were superior to conventional diet-sheet instruction among adults with poorly controlled type 2 diabetes (average pretreatment hemoglobin A_{1c} [A1C] 13%). The patients in the demonstration and videotape groups showed improved dietary knowledge, better adherence

Table 1. Selected Interventions to Improve Medication Adherence

Intervention	Ref.
Educational	
Teaching by nurse and psychologist supplemented with audiotapes	36
Affective	
Home visit to increase family support, group sessions to increase patient confidence and skills	37
Behavioral	
Frequent follow-up by nurse at worksite clinic until treatment goals achieved	38
Feedback through patient record of medications and blood pressure response	39
Combination of medication chart and pill organizer	40
Mailed prescription refill reminder and special packaging	41
Nurse counseling plus reminder chart, structured counseling by pharmacist	42
At end of hospitalization, phasing in patient responsibility for medication administration	43
Telephone reminders and monitoring using computerized telephone system	44
Educational videotape or picture book (note: subjects were asthmatic children)	45

on 7-day food diaries, and substantial improvements in A1C (to 10.6 and 9.6%, respectively, versus no change in the conventional diet-sheet group).

Although the Multiple Risk Factor Intervention Trial (MRFIT) did not achieve its primary goal of reducing mortality from coronary heart disease,²⁹ it was highly successful at reducing the prevalence of risk factors for coronary disease in its special intervention group. MRFIT may be the longest, largest-scale success in improving adherence to cardiovascular dietary recommendations.³⁰ In that study, intensive and sustained counseling of middle-aged men with multiple risk factors for cardiovascular disease was provided by nutrition counselors. Most remarkable is that dietary adherence as measured by 3-day dietary records and improvements in serum lipid levels was largely sustained during 6 years of follow-up.

The use of videotapes by Mahler et al.²² cited earlier in connection with exercise adherence was also successful in reducing dietary fat intake after coronary artery bypass surgery, and, again, the tape presenting the post-operative period as a series of ups and downs generated greater success than the other tape.

Compared to usual care and printed information, dietary advice provided by nurses to healthy patients at risk for coronary heart disease, along with sustained follow-up by these nurses, was associated with slightly greater weight loss, lower intake of total fat and saturated fat, and lower serum cholesterol levels. Roderick et al.³¹ pointed out, however, that the modest gains achieved would be proportionate to the effort and resources required only in patients at the highest risk levels.

What is most striking about interventions to improve dietary adherence is the key role played by health care professionals such as dietitians and nurses. In successful interventions, the physicians' role, if there is any at all, is one of providing approval and initial encouragement. The actual intervention is implemented by nurses or dietitians. It is a matter of speculation whether this reflects greater interest, training in counseling skills, better patient rapport, or more time to devote to dietary matters. We were unable to find any successful interventions that relied primarily on physicians to improve dietary adherence.

Appointment-making and -keeping

is another aspect of chronic disease self-management. For diabetes, this can involve both regular appointments for monitoring and care (typically several times a year) and annual appointments for dilated fundus examinations and comprehensive foot examinations. As with interventions to promote adherence, the track record of any single approach is mixed, but when the literature is viewed as a whole, mail and telephone reminders produce improvements in appointment-keeping.

It has been harder to demonstrate that these same interventions also result in improved glycemic control or reduced hospitalization. For example, Feder et al.³² used mailed prompts to both coronary heart disease patients and their providers to attempt to boost patient clinic attendance and adherence by physicians to treatment guidelines. While their intervention did increase attendance and also increased rates of referral to cardiologists for evaluation, they found no improvement in other markers of quality of care nor any change in lifestyle modifications to reduce risk of recurrent coronary events.

Similarly, in Smith, Weinberger, and Katz' trial³³ of mailed information, appointment reminders, and intense follow-up of missed appointments, the intervention group kept significantly more appointments than the control group, but this improved adherence to outpatient care did not reduce hospitalizations. Of course, management of diabetes was less effective in 1987, and the intervention in this trial did not attempt to improve the quality of care delivered at the visits. Thus, this result is less surprising than that of Feder et al.

Basch et al.³⁴ doubled the rate of retinopathy screening among African Americans with diabetes who had not had an eye exam in the preceding 14 months using a multicomponent educational intervention. Their approach relied heavily on telephone-based problem-solving phone calls to overcome barriers to screening.

Summary and Conclusions

Our glass is half full. A wide variety of methods to improve all aspects of patient adherence to treatment recommendations for diabetes have been studied. Even though many interventions used have been applied broadly to populations without tailoring to individual patients' stage of change,³⁵

a modicum of success is often attained.

Although meta-analyses have shown that broad categories of interventions are, in aggregate, successful, their effects are small. Simultaneously applying several approaches drawn from different modalities (educational, behavioral, affective) tends to produce better results than any single modality. Practitioners seeking to enhance adherence among patients will find no "silver bullet." Rather, we have a collection of reasonably useful tools at our disposal, which we are challenged to use as effectively as we can.

Our efforts are likely to bring the most benefit if temporally targeted to the patients at highest risk of adherence problems and issues: patients being newly introduced to a treatment or patients with previous problems with adherence or adoption of behaviors. If we respect the autonomy of people who live with diabetes while providing them with the educational, behavioral, and emotional support to manage their disease, we have probably fulfilled our health care professional role in promoting adherence.

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References

- ¹National Heart, Lung and Blood Institute, National High Blood Pressure Education Program: *The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure*. NIH Publication No. 98-4080, 1997, available at www.nhlbi.nih.gov
- ²Haynes RB: Determinants of compliance: the disease and the mechanics of treatment. In *Compliance in Health Care*. Haynes RB, Sackett DL, Eds. Baltimore, Md., Johns Hopkins University Press, 1979, p. 49-62
- ³Anderson RM: Patient empowerment and the traditional medical model: a case of irreconcilable differences? *Diabetes Care* 18:412-415, 1995
- ⁴Roter DL, Hall JA, Merisca R, Nordstrom B, Cretin D, Svarstad B: Effectiveness of interventions to improve patient compliance: a meta-analysis. *Medical Care* 36:1138-1161, 1998
- ⁵Haynes RB, Sackett DL (Eds.): *Compliance With Therapeutic Regimens*. Baltimore, Md., Johns Hopkins University Press, 1976

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- ⁶Dunbar-Jacob J, Erlen JA, Schlenk EA, Ryan CM, Sereika SM, Doswell WM: Adherence in chronic disease. In *Annual Review of Nursing Research*. Volume 18. Fitzpatrick R, Goepfinger J, Eds. New York, Springer Publishing Co., 2000, p. 48–90
- ⁷Burke LE, Dunbar-Jacob JM, Hill MN: Compliance with cardiovascular disease prevention strategies: a review of the research. *Ann Behav Med* 19:239–263, 1997
- ⁸Cramer JA, Scheyer RD, Mattson RH: Compliance declines between clinic visits. *Arch Intern Med* 150:1509–1510, 1990
- ⁹Langfeld SB: Hypertension: deficient care of the medically served. *Ann Intern Med* 78:19–23, 1973
- ¹⁰Haynes RB, Sackett DL, Gibson ES, Taylor DW, Hackett BC, Roberts RS, Johnson AL: Improvement of medication adherence in uncontrolled hypertension. *Lancet* 1:1265–1268, 1976
- ¹¹Morrell RW, Park DC, Kidder DP, Martin M: Adherence to antihypertensive medications across the life span. *Gerontologist* 37:609–619, 1997
- ¹²Park DC, Hertzog C, Leventhal H, Morrell RW, Leventhal E, Birchmore D, Martin M, Bennett J: Medication adherence in rheumatoid arthritis patients: older is wiser. *J Am Geriatr Soc* 47:172–183, 1999
- ¹³Oldridge NB: Compliance and dropout in cardiac exercise rehabilitation. *J Cardiac Rehabil* 4:166–177, 1984
- ¹⁴Jones JK, Gorkin L, Lian JF, Staffa JA, Fletcher AP: Discontinuation of and changes in treatment after start of new courses of antihypertensive drugs: a study of a United Kingdom population. *BMJ* 311:293–295, 1995
- ¹⁵Fiore MC, Smith SS, Jorenby DE, Baker TB: The effectiveness of the nicotine patch for smoking cessation: a meta-analysis. *JAMA* 271:1940–1947, 1994
- ¹⁶Sherbourne CD, Hays RD, Ordway L, DiMatteo MR, Kravitz RL: Antecedents of adherence to medical recommendations: results from the Medical Outcomes Study. *J Behav Med* 15:447–468, 1992
- ¹⁷The DPP Research Group: The Diabetes Prevention Program: design and methods for a clinical trial in the prevention of type 2 diabetes. *Diabetes Care* 22:623–634, 1999
- ¹⁸Norris SL, Engelgau MM, Venkat Narayan KM: Effectiveness of self-management training in type 2 diabetes. *Diabetes Care* 24:561–587, 2001
- ¹⁹Mason BL, Matsuyama JR, Jue SG: Assessment of sulfonylurea adherence and metabolic control. *Diabetes Educ* 21:52–57, 1995
- ²⁰Carlson JJ, Johnson JA, Franklin BA, VanderLaan RL: Program participation, exercise adherence, cardiovascular outcomes, and program cost of traditional versus modified cardiac rehabilitation. *Am J Cardiol* 86:17–23, 2000
- ²¹Jakicic JM, Winters C, Lang W, Wing RR: Effects of intermittent exercise and use of home exercise equipment on adherence, weight loss, and fitness in overweight women: a randomized trial. *JAMA* 282:1554–1560, 1999
- ²²Mahler HI, Kulik JA, Tarazi RY: Effects of a videotape information intervention at discharge on diet and exercise compliance after coronary bypass surgery. *J Cardiopulm Rehabil* 19:170–177, 1999
- ²³Annesi JJ: Effects of computer feedback on adherence to exercise. *Percept Mot Skills* 87:723–730, 1998
- ²⁴King AC, Taylor CB, Haskell WL, Debusk RF: Strategies for increasing early adherence to and long-term maintenance of home-based exercise training in healthy middle-aged men and women. *Am J Cardiol* 61:628–632, 1988
- ²⁵Jeffery RW, Wing RR, Thorson C, Burton LR: Use of personal trainers and financial incentives to increase exercise in a behavioral weight-loss program. *J Consult Clin Psychol* 66:777–783, 1998
- ²⁶Metz JA, Kris-Etherton PM, Morris CD, Mustad VA, Stern JS, Oparil S, Chait A, Haynes RB, Resnick LM, Clark S, Hatton DC, McMahon M, Holcomb S, Snyder GW, Pi-Sunyer FX, McCarron DA: Dietary compliance and cardiovascular risk reduction with a prepared meal plan compared with a self-selected diet. *Am J Clin Nutr* 66:373–385, 1997
- ²⁷Windhauser MM, Evans MA, McCullough ML, Swain JF, Lin PH, Hoben KP, Plaisted CS, Karanja NM, Vollmer WM: Dietary adherence in the Dietary Approaches to Stop Hypertension trial. *J Am Diet Assoc* 99 (Suppl. 8):S76–S83, 1999
- ²⁸McCulloch DK, Mitchell RD, Ambler J, Tattersall RB: Influence of imaginative teaching of diet on compliance and metabolic control in insulin dependent diabetes. *BMJ* 287:1858–1861, 1983
- ²⁹MRFIT Research Group: Multiple Risk Factor Intervention Trial: risk factor changes and mortality results. *JAMA* 248:1465–1477, 1982
- ³⁰Dolecek TA, Milas NC, Van Horn LV, Farrand ME, Gorder DD, Duchene AG, Dyer JR, Stone PA, Randall BL: A long-term nutrition intervention experience: lipid responses and dietary adherence patterns in the Multiple Risk Factor Intervention Trial. *J Am Diet Assoc* 86:752–758, 1986
- ³¹Roderick P, Ruddock V, Hunt P, Miller G: A randomized trial to evaluate the effectiveness of dietary advice by practice nurses in lowering diet-related coronary heart disease risk. *Br J Gen Pract* 47:7–12, 1997
- ³²Feder G, Griffiths C, Eldridge S, Spence M: Effect of postal prompts to patients and general practitioners on the quality of primary care after a coronary event: randomized controlled trial. *BMJ* 318:1522–1526, 1999
- ³³Smith DM, Weinberger M, Katz BP: A controlled trial to increase office visits and reduce hospitalizations of diabetic patients. *J Gen Intern Med* 2:232–238, 1987
- ³⁴Basch CE, Walker EA, Howard CJ, Shamoan H, Zybert P: The effect of health education on the rate of ophthalmic examinations among African Americans with diabetes mellitus. *Am J Public Health* 89:1878–1882, 1999
- ³⁵Prochaska JO, DiClemente CC, Velicer WF, Ginpil S, Norcross JC: Predicting change in smoking status for self-changers. *Addict Behav* 10:395–406, 1985
- ³⁶Nessman DG, Carnahan JE, Nugent CA: Increasing compliance: patient-operated hypertension groups. *Arch Intern Med* 140:1427–1430, 1980
- ³⁷Morisky DE, Levine DM, Green LW, Shapiro S, Russell RP, Smith CR: Five-year blood pressure control and mortality following health education for hypertensive patients. *Am J Public Health* 73:153–162, 1983
- ³⁸Logan AG, Milne BJ, Achber C, Campbell WP, Haynes RB: Work-site treatment of hypertension by specially trained nurses: a controlled trial. *Lancet* 2:1175–1178, 1979
- ³⁹Saunders LD, Irwig LM, Gear JSS, Ramushu DL: A randomized controlled trial of compliance improving strategies in Soweto hypertensives. *Med Care* 29:669–678, 1991
- ⁴⁰Park DC, Morrell RW, Frieske D, Kincaid D: Medication adherence behaviors in older adults: effects of external cognitive supports. *Psychol Aging* 7:252–256, 1992
- ⁴¹Skaer TL, Sclar DA, Markowski DJ, Won JKH: Effect of value-added utilities on prescription refill compliance and healthcare expenditures for hypertension. *J Hum Hypertens* 7:515–518, 1993
- ⁴²Raynor DK, Booth TG, Blenkinsopp A: Effects of computer generated reminder charts on patients' compliance with drug regimens. *BMJ* 306:1158–1161, 1993
- ⁴³Lowe CJ, Raynor DK, Courtney EA, Purvis J, Teale C: Effects of self-medication programme on knowledge of drugs and compliance with treatment in elderly patients. *BMJ* 310:1229–1232, 1995
- ⁴⁴Friedman RH, Kazis LE, Jette A, Smith MB, Stollerman J, Torgerson J, Carey K: A telecommunications system for monitoring and counseling patients with hypertension. *Am J Hypertens* 9:285–292, 1996
- ⁴⁵Holzheimer L, Mohay H, Masters IB: Educating young children about asthma: comparing the effectiveness of a developmentally appropriate asthma education video tape and picture book. *Child Care Health Devel* 24:85–99, 1998

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