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Computer-Assisted Intervention Improves Patient-Centered Diabetes Care by Increasing Autonomy Support

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Objective: To determine if a patient-centered, computer-assisted diabetes care intervention increased perceived autonomy support, perceived competence (from self-determination theory), and if these constructs mediated the effect of the intervention on ADA/NCQA recommended diabetes care outcomes. ***Design:*** A randomized controlled trial of 866 adult type 2 diabetes patients in heterogeneous primary care settings in Colorado. ***Main Outcome Measures:*** Perceived autonomy support, perceived competence, patient satisfaction, glycemic control (HbA1c), ratio of total to HDL cholesterol, diabetes distress, and depressive symptoms. ***Results:*** The computer-assisted intervention increased patient perception of autonomy support relative to a computer-based control condition ($p < .05$). Change in perceived competence partially mediated the effects of increased autonomy support on the change in lipids, diabetes distress, and depressive symptoms. The construct of autonomy support was found to be separate from that of patient satisfaction. ***Conclusions:*** A patient-centered, computer-assisted intervention was effective in improving diabetes self-management outcomes, in part, because it increased patients' perception that their autonomy was supported which changed perceived competence. These findings support the self-determination model for health behavior change and the chronic care model and support the further study of the use of these technologies to motivate patients to improve their health outcomes.

Keywords: patient-centered diabetes care, autonomy support, diabetes quality of care, computer-assisted intervention, perceived competence

Although there is an important need to identify the active mediating mechanisms of behavioral interventions, relatively little such research has been conducted (Baranowski & Stables, 2000). This is especially true of practical interventions designed and tested for effectiveness in a real-world setting (Glasgow, 2003). Identification of the mediating mechanisms establishes the necessary scientific links between theories of human behavior and the intervention components, and thus facilitates the improvement of interventions, the confirmation of theory, and determining if the process of care is meeting established standards (MacKinnon & Dwyer, 1993). For example, the American Board of Internal Medicine (ABIM) has established that all medical care should be guided by the three principles: (1) the primacy of patient well-being; (2) the respect for autonomy; and (3) social justice (ABIM, 2002). Support of autonomy is also a key element of self-determination theory, a general theory of human motivation (Ryan & Deci, 2000). The current report seeks to test whether or not a computer-assisted intervention accomplishes its effect on patient outcomes by supporting patient autonomy, thus linking the intervention to motivation, and supporting the tenets of the ABIM Charter.

This article is a secondary analysis of data from a large, randomized study of a computer-assisted intervention that effectively improved both patient-centered aspects of diabetes care (e.g., setting collaborative goals, counseling on lifestyle behaviors) and increased the number of laboratory assays (Glasgow et al., 2005) as recommended by the National Committee on Quality Assurance (NCQA)/American Diabetes Association Provider Recognition Program (PRP; Joyner, McNeely, & Kahn, 1997; NCQA & ADA, 2003). Although these initial findings link the intervention to patient-centered care outcomes, the question remains as to how patient-centered care and computer-assisted interventions improve outcomes. One hypothesis is that computer-assisted interventions, if properly designed, support autonomy by obtaining a patient perspective, providing intervention options and encouraging choice, and informing patient-provider interactions, which motivate patients to improve outcomes.

To test this idea, the research team included measures of motivation from self-determination theory (SDT)—a general theory of human motivation (Deci & Ryan, 1985; Ryan & Deci, 2000). SDT is the only theory of motivation that proposes that humans have a need for autonomy (or volition) and its support. Autonomy support can be measured on the health care climate questionnaire (HCCQ; Williams, Grow, Freedman, Ryan, & Deci, 1996), thus allowing an

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empirical test of the hypothesis above. SDT also assumes humans have a need for competence (similar to self-efficacy in social learning theory; Bandura, 1997). SDT theorists propose that when the social surround supports these needs, humans become more motivated to adopt recommended health behaviors.

Autonomy support is defined by the extent to which patients perceive that the health care team elicits and acknowledges their perspectives, provides a menu of options including not accepting the team's recommendations, supports patient initiatives for change, provides a rationale for any advice given, and minimizes physician control of/over the patient. The provision of computer-assisted information is hypothesized to be perceived as more autonomy supportive because—if developed in ways congruent with the above principles—computers may be perceived as less judgmental and controlling when providing information and a rationale for patients to establish a plan and participate actively in their own care. Previous studies have demonstrated a direct (Williams, Freedman & Deci, 1998) and indirect (Williams, McGregor, Zeldman, Freedman, & Deci, 2004) effect of the diabetes team's autonomy support on change in HbA1c over 12 months. Thus, relatively intensive interventions with more extensive contact time between staff and patients are perceived as more autonomy supportive and result in greater motivation as well as improved outcomes. However, there are no reports of how integration of computer-assisted technology into primary care visits for diabetes may support patient autonomy and perceived competence for diabetes self-management. If computer technologies improve patient outcomes while supporting patient autonomy, they may allow for more cost-effective treatments with greater reach (e.g., Glasgow, Bull, Piette, & Steiner, 2004).

Analysis of this data set also allows for further validation of the construct of autonomy support from SDT. Medical researchers have developed general measures of patient satisfaction that are neither theoretically based, nor directly related to specific aspects of human behavior. SDT theorists propose that it is not general satisfaction that is important for sustained behavior change, but rather the specific satisfaction of the needs for autonomy, competence, and relatedness that energizes human behavior. We will test whether these two constructs of autonomy support and satisfaction can be differentiated from each other. We will also test whether perceived competence mediates the effect of the intervention on the diabetes outcomes.

This analysis tested the impact of the computer-assisted intervention on perceived autonomy support and perceived competence for diabetes self-management. Also, it tested the relations between changes in those measures of motivation improvement and quality of life, biologic outcomes (HbA1c levels, and lipids), and depressive symptoms over 12 months. Three other reports have presented primary outcome results from this randomized trial (Glasgow, Nutting et al., 2004; Glasgow et al., 2005; Williams, McGregor, King, Nelson, & Glasgow, 2005), but these have not tested the effect of the intervention on change in autonomy support and competence, nor tested the path models regarding the effect of change in autonomy support and competence on the diabetes outcomes, and the data presented here have not previously been published.

The present article examines the structural relations among provider autonomy support, patient perceived competence, and a number of diabetes-relevant outcomes. Specifically, in line with self-determination theory, we hypothesized that computer-assisted intervention would increase perceived autonomy support and competence over 12 months, that increases in autonomy support at 6 months would predict increases in patient competence at 12 months, and that change in autonomy support and perceived competence from baseline to 12 months would predict improvements on the 12-month individual diabetes outcomes. We expected these associations to be the same strength in both groups, because when a psychological need (e.g., autonomy) is supported it should result in the same amount of change in behavior independent of intervention status. Also, autonomy support and patient satisfaction were hypothesized to be best represented as separate constructs.

Research Design and Methods

The Diabetes Priority Program was a collaboration among the Kaiser Permanente Colorado research team, the Copic Insurance team, and participating primary care practices throughout Colorado. The current analysis resulted from collaboration between the human motivation research group at the University of Rochester and the Kaiser Permanente team to determine if the changes observed were consistent with self-determination theory. Details of the physician and patient recruitment, the CONSORT figure, and 12-month outcomes are published elsewhere (Glasgow et al., 2005). A two-group, cluster randomized design was used. Briefly, 30 separate primary care practices containing 52 physicians were randomized to two conditions. A total of 866 patients met eligibility requirements (over 25 years of age, ability to read English, and type 2 diabetes), provided informed consent, and participated. There were 469 patients in the intervention (of 621 eligible and invited, or 75.5%), and 417 (of 566, or 73.7%) patients in the control condition.

The Diabetes Priority Program

Participants were asked to come 30 minutes early to their scheduled primary care diabetes-related visits, 6 months apart, to complete a computerized touch screen assessment and action-planning procedure. Participants were asked to recall when they last received the 11 diabetes care items contained in the ADA/NCQA Provider Recognition Program (PRP; 2003) measures (Joyner et al., 1997).

The second part of the touch screen computerized program involved establishing a self-management action plan related to dietary, physical activity, and/or smoking behaviors. The program assessed current self-management behaviors, provided tailored feedback, and guided users through selecting specific activities in the goal area, identifying barriers and selecting strategies to overcome the barriers. The computer generated for the patient an individualized action plan, including a summary of self-management goals and assays for which the patient was due; a one-page summary of the patient's needed assessments and self-management goals, highlighting issues the patient would like to discuss with the physician, and a detailed printout to be used by the office's designated care manager. Care managers were regular office staff; usually nurses were trained to use a patient-centered self-management intervention lasting 8–10 minutes (Holman & Lorig, 2000; Glasgow, Funnell, Bonomi, Davis, Beckman, & Wagner, 2002). This included review of patient self-care goals and medical care needs and problem-solving strategies to overcome barriers to their goals. The care manager also made brief follow-up calls after visits. After 6 months, these procedures were repeated. All aspects of care were designed to be consistent with the Chronic Care Model for self-management support in primary care settings (Wagner, 1998; Glasgow et al., 2005).

Comparison Condition

Touch screen computer assessment procedures were completed by control patients who completed the PRP measures and general health risk issues (e.g., use of seatbelts, cancer screening) and were also matched for number of contacts and the novelty of using a diabetes care related, interactive touch screen computer program. Control patients also received a printout on general health risks, but did not set self-management goals, meet with a care manager, or receive follow-up phone calls.

Measures

Motivational variables included patients' perceptions of provider autonomy support, assessed by the 6-item modified Health Care Climate Questionnaire (mHCCQ) (Williams et al., 2005), rated on a 1 (*strongly disagree*) to 7 (*strongly agree*) Likert-type scale, and patients' perceptions of competence, assessed by the 4-item Perceived Competence Scale (PCS; Williams et al., 1998, 2004), rated on a 1 (*not at all true*) to 7 (*very true*) Likert-type scale. Autonomy support was assessed at baseline, 6 and 12 months, while competence was assessed at baseline and 12 months. The reason autonomy support at 6 months rather than at 12 months was tested in the path model is because autonomy support was hypothesized to facilitate increase in perceived competence. This is best represented with change in autonomy support over 6 months, predicting change in perceived competence over 12 months to avoid same day measurement error. Change in autonomy over 6 months and change in perceived competence from T1 to T3 was hypothesized to predict change in the diabetes outcomes.

The 6-item mHCCQ, based on the 15-item HCCQ (Williams, Grow, Freedman, Ryan, & Deci, 1996; Williams et al., 2005), and the 4-item Perceived Competence Scale for diabetes, were tested for internal consistency. For autonomy support, Cronbach's alpha measured at baseline was .92; item-to-total correlations ranged from .70 to .83. Alpha at T2 (6 months) was .93. A confirmatory factor analysis (CFA) was performed on the baseline assessment, using the 6 items as observed indicators. The single-factor solution demonstrated adequate fit (CFI = 1.00, IFI = 1.00, TLI = .99), all standardized item loadings $>$ 0.70. Cronbach's alpha for the perceived competence scale was .94 at baseline (item-to-total correlations .81 to .88), and .96 at T3 (12 months). A CFA using each of the four items as observed indicators was performed on the baseline assessment; the single-factor solution demonstrated very good fit (CFI = 1.00, IFI = 1.00, TLI = .97), all standardized item loadings $>$ 0.80. Thus, the psychometric properties of the two primary motivational scales were acceptable (Table 1).

Patient satisfaction was assessed by five items from the NCQA/ADA Provider Recognition Program (Joyner et al., 1997). A sample item includes satisfaction with the provider's "explaining test results in a way I can understand." Items were rated on a 5-point scale; a satisfaction score was calculated for each point as the mean of the 5 items. The internal consistency for baseline patient satisfaction was α = .88.

Four diabetes outcomes were assessed. First, HbA1c assays, using a National Glycohemoglobin Standardization Program (NGSP) certified Bui-Rad Variant 2 analyzer (reference range: 4.1% – 6.5%), were conducted by the University of Colorado Health Sciences Center. Second, a lipid ratio score was calculated based on the total to HDL cholesterol ratio, on the basis of a nonfasting assay conducted for all participants. Third, the Diabetes Distress Scale (DDS) was administered to assess diabetes-specific quality of life (Polonsky et al., 2005). The internal consistency of the DDS in the current study was α = .93. Fourth, the nine-item Patient Health Questionnaire (PHQ-9) was administered to assess depressive symptoms (Kroenke, Spitzer, & Williams, 2001). The internal consistency of the PHQ-9 in the current study was α = .86.

Analytic strategy. Repeated measures ANCOVA was used to test the effect of the intervention on autonomy support and perceived competence. Structural equation modeling (SEM) was used to test the SDT model with AMOS 6.0. First, as per Byrne (2001), the unconstrained model was tested for each group separately. Second, the unconstrained model was tested for both groups si-

Table 1
Item Means, Standard Deviations, and Item–Total Statistics for Provider Autonomy Support and Competence at Baseline (N = 886)

Item	*M* ± *SD*	Item-total correlation	Factor loading
Autonomy support			
1. I feel that my doctor (health team) gives me choices and options.	5.90 ± 1.36	.80	.85
2. I feel that my doctor (health team) understands me.	5.95 ± 1.34	.83	.89
4. My doctor (health team) shows confidence in my ability to make changes.	5.96 ± 1.27	.73	.78
7. My doctor (health team) encourages me to ask questions.	6.05 ± 1.37	.77	.85
10. My doctor (health team) listens to how I would like to do things.	5.83 ± 1.37	.75	.76
14. My doctor (health team) tries to understand how I see things before suggesting a new way.	5.68 ± 1.43	.70	.70
Competence			
1. I am confident that I can take care of my diabetes.	5.52 ± 1.53	.86	.92
2. I can handle my diabetes now.	5.42 ± 1.59	.88	.94
3. I can do my own routine diabetes care now.	5.64 ± 1.58	.84	.85
4. I can meet the challenge of controlling my diabetes.	5.65 ± 1.50	.81	.80

Note. Factor loadings represent standardized regression weights from a CFA.

Table 2
Correlations Among Study Variables

	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age	.24**	−.08*	−0.05	−.14**	−.15**	−.25**	−.23**	−.10**	−0.07	.15**	.12**	.14**	.14**
2. # chron cond	1	−.07*	−.09*	−0.06	−.09*	.09**	0.02	.26**	.21**	0.01	0.05	−0.03	0.04
3. A1C T1		1	.66**	.11**	.10*	.18**	.21**	0.04	.10*	−0.04	−0.03	−.18**	−.20**
4. A1C T3			1	0.05	.16**	.11**	.22**	−0.06	0.05	−0.01	−0.02	−.09*	−.16**
5. Lipid ratio T1				1	.55**	0.04	0.04	−0.02	0.01	−.10**	−.09*	−0.07	−.14**
6. Lipid ratio T3					1	.09*	.13**	0.02	0.06	−0.08	−.10*	−0.07	−0.07
7. DSS T1						1	.67**	.54**	.49**	−.48**	−.27**	−.45**	−.30**
8. DSS T3							1	.45**	.58**	−.40**	−.32**	−.36**	−.44**
9. Dep Sx T1								1	.58**	−.25**	−.21**	−.26**	−.19**
10. Dep Sx T3									1	−.28**	−.19**	−.25**	−.32**
11. AutSupp T1										1	.53**	.36**	.31**
12. AutSupp T2											1	.151 (**)	.28**
13. CompT1												1	.37**
14. CompT3													1

Note. # chron cond = number of chronic conditions; A1C = HbA1c; DSS = Diabetes Distress Scale; Dep Sx = depressive symptoms; AutSupp = provider autonomy support; Comp = perceived competence; T1 = baseline; T2 = 6 months; T3 = 12 months.
* $p < .05$. ** $p < .01$.

multaneously. In order to test for differences between the intervention and community care groups, parameter estimates (specifically, regression weights) were constrained to be equal across the two groups. A substantial decrement in the fit indices for the constrained model, compared to those for the previous unconstrained model, would indicate that regression weights should be allowed to differ for the two groups; if fit indices remain comparable, however, then on the principle of parsimony the hypothesis of no differences between groups, represented by the constrained model, should be accepted.[1] Only the figure for the final model will be shown.

Results

Preliminary Analyses

One-way analysis of variance was used to test for between-condition differences on sociodemographic and baseline measures. Comparisons revealed no differences in socioeconomic status, although there was a significant difference in age, with patients in usual care ($M = 64.63$, $SD = 12.42$) being somewhat older on average than those in the intervention ($M = 61.48$, $SD = 12.64$), $F(1, 885) = 13.94$, $p < .01$. In addition, the two groups differed in number of chronic conditions, with usual care patients on average endorsing more conditions ($M = 2.22$, $SD = 1.42$) than intervention patients ($M = 1.93$, $SD = 1.50$), $F(1, 884) = 8.46$, $p < .01$. The groups did not differ on baseline measures or other demographics.

Primary Analyses

Testing the hypotheses and the SDT Model for diabetes primary outcomes. Table 2 presents correlations among all the study variables used for the SEM analyses. Six-month provider autonomy support (T2) was significantly correlated with competence at 12 months (T3), and with 12-month indicators of cholesterol ratio, diabetes distress, depressive symptoms, and the behavioral composite. Competence at 12 months was associated with 12-month outcomes, HbA1c, diabetes distress, and depressive symptoms. All significant correlations were in the predicted direction.[2]

Between-groups differences on improvements in autonomy support and competence. Separate ANCOVA analyses were performed to test the hypothesis that the intervention would have a positive impact on the experience of provider autonomy support and on perceived competence, after controlling for baseline autonomy support and competence, and adjusting for age and number of chronic conditions. Patients in the intervention experienced greater autonomy support from their providers than did patients in the usual care condition, and this difference was significant at 12 months ($p < .05$), but not at 6 months ($p > .30$). There was a trend for the patients to experience greater perceived competence at 6 ($p > .20$) and then 12 months ($p > .10$), but neither increase in perceived competence was significant. For these results, see Table 3.

Testing the hypotheses and the SDT Model for diabetes outcomes. The SDT model for the diabetes outcomes was tested with a series of SEM analyses (see Figure 1). Initial fit of the baseline unconstrained model was acceptable for both groups when tested separately (for the intervention group: $\chi^2(333) = 870.29$, $p < .01$, CFI = .93, TLI = .92, RMSEA = .06; for the control/usual care group: $\chi^2(333) = 817.44$, $p < .01$, CFI = .94, TLI = .93, RMSEA = .06). The model was next tested for both groups simultaneously. The fit was acceptable: $\chi^2(666) =$

[1] Because of its sensitivity to trivial discrepancies, the chi-square statistic was not utilized in decision-making about model fit. However, for the sake of completeness the chi-square statistic is provided. Decision-making about model fit was based on the CFI, TLI, and RMSEA indices. For the first two of these, values above .90 indicate acceptable fit, while for RMSEA values > .10 indicate acceptable fit.

[2] Although age and number of chronic conditions displayed significant correlations with a number of the study variables, including these two indicators in the SEM model resulted in an unidentified model which could not easily be corrected. Accordingly, these two indicators were left out of the final SEM model.

Table 3
Motivational Outcomes

Outcome	Usual care *M* (*SE*)	Intervention *M* (*SE*)	*p*-value
BL to 12M change* in provider autonomy support	5.89 (.05)	6.05 (.05)	.03
BL to 12M change* in perceived competence	5.75 (.07)	5.90 (.06)	.10

Note. BL = baseline; 12M = 12-month; *M* = mean; *SE* = standard error.
* Values are estimated means resulting from partialing out of the baseline values, age, and number of chronic conditions.

1,687.74, $p < .01$, CFI = .94, TLI = .92, RMSEA = .04. The unconstrained model thus had acceptable fit across both groups.

In order to test for differences between groups, regression weights (19 in total) were constrained to be equal across groups. The fit for the constrained model was acceptable: $\chi^2(686)$ = 1,728.19, $p < .01$; CFI = .94; TLI = .93; RMSEA = .04. Because the last three of these fit indices were essentially the same as those for the previous unconstrained model, there was no degradation in the fit of the model when these parameters were constrained to be equal. Therefore, the second, constrained model was accepted, based on parsimony, as displayed in Figure 1, suggesting there were no significant differences between groups in the parameters tested by the model.

As a final test, regression weights for 12-month competence were constrained to zero in order to examine whether competence would mediate the impact of autonomy support on the 12-month diabetes distress and depressive symptoms outcomes, for which both autonomy support and competence had significant pathways in the previously tested model. The model in which the pathways from competence were constrained to zero had acceptable fit: $\chi^2(690)$= 1,862.81, $p < .01$; CFI = .93; TLI = .92; RMSEA = .04, although the CFI and TLI values were slightly less than for the model in which no constraints were imposed on competence. As Figure 1 shows, the parameter estimates from autonomy support to diabetes distress and to depressive symptoms were larger when competence was constrained to zero, indicating that the effect of change in autonomy support on change in diabetes distress and depressive symptoms was partially mediated by change in perceived competence.

In sum, baseline levels of competence had an impact on all four secondary diabetes outcomes at the time of initial assessment. Change in provider autonomy support over 6 months accounted for increases in competence and improvements in lipid ratios, diabetes distress, and depressive symptoms over 12 months. However, change in 12-month competence accounted for improvements only on the diabetes distress and depressive symptoms indicators, and partially mediated the impact of change in provider autonomy support on these two outcomes.

Autonomy support and patient satisfaction. SEM was used to determine whether autonomy support and patient satisfaction are better represented as a single factor or two factors. In each model, the five items from the patient satisfaction scale were used as observed indicators for satisfaction, and the six items from the mHCCQ were used to represent the observed indicators for auton-

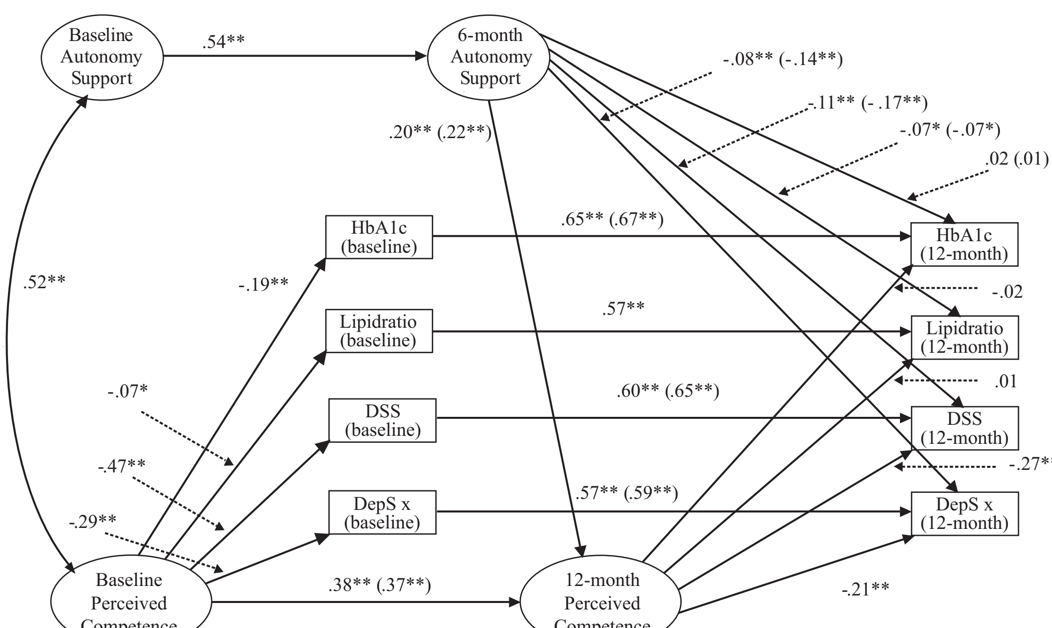

Figure 1. Final SDT Model for Diabetes Outcome. Regression weights constrained to be equal across groups. Model Fit: $\chi^2(686)$=1,728.19, $p < .001$; CFI = .94; TLI = .93; RMSEA = .04. Values represent standardized path estimates. Those in parentheses represent values when 12-month Competence was constrained to zero [fit indices for that model: $\chi^2(690)$ = 1,862.81, $p < .01$; CFI = .93; TLI = .92; RMSEA = .04]. * $p < .05$. ** $p < .01$.

omy support. The fit of the 2-factor solution with separate latent variables for both patient satisfaction and autonomy support met acceptable standards for model fit (CFI = .99, IFI = .99, TLI = .98, RMSEA = .04), while the single-factor solution failed to meet acceptable standards for any of the model fit statistics (CFI = .82, IFI = .82, TLI = .71, RMSEA = .18). In addition, for the two-factor solution, standardized item loadings on their respective factors all exceeded .7, whereas for the single-factor solution, standardized loadings for the patient satisfaction items ranged from .50 to .59 while the loadings for the autonomy support parcels ranged from .69 to .86. In spite of their moderate correlation ($r = .51$, $p < .01$), these constructs are best represented separately.

Discussion

A computer-assisted intervention designed to improve patient-centered aspects of diabetes care and to increase completion of NCQA/ADA recommended lab assays was found to increase patient experience of autonomy support from their care practice. However, perceived competence was not significantly increased by the intervention. Multi-group modeling demonstrated that the process of change was equivalent between the groups supporting the SDT process of change. Mediation analyses indicated that the effect of the increase in autonomy support on the diabetes distress and depressive symptoms was partially mediated by the change in perceived competence. Thus, the major finding from this planned secondary analysis indicates that this patient-centered, computer-assisted intervention was effective, in part, because, as suggested by self-determination theory, it increased patients' perception that their autonomy was supported for self-managing their diabetes. The findings that the computer-assisted interventions improved diabetes outcomes in part by increasing patient perception of autonomy support are consistent with the American Board of Internal Medicine's charter for health care (2002) and the recommendations of NCQA/ADA and thus justifies the further study and use of these technologies in patient care.

The implications for adding information technologies to health care delivery sites in a patient-centered manner and consistent with motivation theory could easily extend throughout health care. Many chronic and preventive services are not provided (Coffield et al., 2001; McGlynn et al., 2003), in part because these services are not feasible to be provided by the clinicians due to competing demands, lack of time, and constraints on the office systems (Yarnell, Pollack, Ostbye, Krause, & Michener, 2003). We speculate that patients perceived the intervention as autonomy supportive because (1) the interactive computer program assessed patient concerns and preferences in setting collaborative goals without being perceived by the patient as judgmental or controlling; (2) there was a strong emphasis on patient choice in developing action plans (King et al., 2004); and (3) the physician and care manager discussed and followed up on these plans.

Additional findings from this analysis include confirming the following relations between autonomy support and: (1) increase in perceived competence, (2) reduction in diabetes distress, (3) reduction in depressive symptoms, and (4) improvement in serum lipid ratios. Change in competence was found to predict the following: (1) less diabetes distress and (2) a reduction in depressive symptoms. It is unclear why change in autonomy support and change in perceived competence were not predictive of improved glycemic control as had been found in two previous reports (Williams et al., 1998, 2004). However, perceived competence did account for significant variance in HbA1c at both time points. One possibility is that many participants had acceptable levels of glycemic control at baseline ($M = 7.3\%$) with limited room for improvement. These findings further support the self-determination theory model for health behavior partially explaining how and why the Chronic Care Model may work (Bodenheimer, Wagner, & Grumach, 2002a, 2002b).

Finally, this analysis provides evidence that autonomy support and patient satisfaction are related, but separate constructs. Although autonomy support may be an outcome of health care interventions in itself (ABIM, 2002), researchers are encouraged to consider it as a process variable related to motivation, and patient satisfaction measures may be most useful as an outcome measure alone.

The limitations of this article include that it was a secondary analysis, the variances accounted for were modest, and that not all of the elements of the self-determination theory model for health behavior were measured (autonomous self-regulation was not assessed). Thus, it may be that optimal systems need to include both computer-assisted intervention followed by interaction with a care team member to met patient need for autonomy. However, previous trials in diabetes (Williams et al., 2004), in tobacco (Williams et al., 2006), and elsewhere (Deci & Ryan, 2002) have established these relations. The strengths of this analysis include that the analysis was planned and tested for effectiveness in a real-world setting. It had a reasonably large sample size and included a multivariable analysis to assess mediation.

In conclusion, support was found for the effect of the patient-centered computer- assisted intervention on patients' perceptions of provider autonomy support and of perceived competence with respect to diabetes. The experience of autonomy support by patients in the intervention and control conditions in primary care settings throughout Colorado was also found to account for increases in perceived competence. In turn, change in autonomy support and perceived competence accounted for improvement on several important diabetes-related outcomes. Evidence was also found for the distinctiveness of the constructs of provider autonomy support and patient satisfaction. Future research is called for to determine if this effect is reproduced in the management of other chronic diseases and to determine its reach and cost-effectiveness (Glasgow, Bull et al., 2004).

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