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Health Behavior Change Counseling in Surgery for Degenerative Lumbar Spinal Stenosis. Part I: Improvement in Rehabilitation Engagement and Functional Outcomes

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Abstract

Objective: To examine whether a brief motivational interviewing [MI]–based health behavior change counseling (HBCC) intervention increased patient participation in physical therapy and/or home exercise programs (HEPs), reduced disability, and improved health status after surgery for degenerative lumbar spinal stenosis.

Design: Prospective clinical trial.

Setting: Academic medical center.

Participants: From December 2009 through August 2012, consecutive patients (N=122) underwent surgery for degenerative lumbar spinal stenosis and, based on enrollment date, were prospectively assigned to a control (n=59) or HBCC intervention (n=63) group in a prospective, lagged-control clinical trial.

Interventions: Brief MI-based HBCC versus attention control.

Main Outcome Measures: Rehabilitation participation (primary); disability and health status (secondary). Therapists assessed engagement in, and patients reported attendance at, postoperative rehabilitation (physical therapy and/or HEP). At 3 and 6 months, disability and health status were assessed (Oswestry Disability Index [ODI] and Medical Outcomes Study 12-Item Short-Form Health Survey, version 2 [SF-12v2]) (significance, $P<.05$).

Results: Compared with controls, HBCC patients had significantly higher rehabilitation engagement (21.20 ± 4.56 vs 23.57 ± 2.71 , respectively; $P<.001$), higher physical therapy ($.67\pm.21$ vs $.82\pm.16$, respectively; $P<.001$) and HEP ($.65\pm.23$ vs $.75\pm.22$, respectively; $P=.019$) attendance, and better functional outcomes at 3 months (difference: ODI, -10.7 ± 4.4 , $P=.015$; SF-12v2, 6.2 ± 2.2 , $P=.004$) and 6 months (difference: ODI, -12.7 ± 4.8 , $P=.008$; SF-12v2, 8.9 ± 2.4 , $P<.001$).

The proportion of the HBCC intervention impact on functional recovery mediated by rehabilitation participation was approximately half at 3 months and one-third at 6 months.

Conclusions: HBCC can improve outcomes after spine surgery through improved rehabilitation participation.

Keywords

Laminectomy; Motivational interviewing; Rehabilitation; Spinal stenosis; Spine

In the United States, surgery for degenerative lumbar spinal stenosis is one of the most costly and common inpatient procedures. The frequency^{1–3} and cost⁴ of these procedures have risen dramatically during the past 2 decades. Despite advances in surgical techniques to treat this condition, there is significant variability in patient outcomes after surgery, with nearly 40% of patients reporting persistent pain and disability.^{5,6} For many patients, preoperative deconditioning^{7–9} or surgical incisions through muscle groups¹⁰ have weakened the back muscles. Major goals of physical therapy (PT) and home exercise programs (HEPs) for patients recovering from surgery for lumbar spinal stenosis are to retrain muscles, improve strength, and increase endurance.

Research suggests that postoperative PT and HEPs may influence functional recovery. A recently published Cochrane review¹¹ identified 22 studies of 2503 participants that evaluated the effectiveness of active treatments in rehabilitation after lumbar spine surgery and found evidence of the beneficial impact of intensive exercise programs or HEPs on the short-term reduction in pain and improvement in functional recovery. Two randomized controlled trials^{12,13} including 103 participants showed that high-intensity exercise programs were more effective than low-intensity exercise at reducing pain. Another trial¹⁴ of patients randomly assigned to receive 6 weeks of high-intensity dynamic back extension and abdominal exercise reported earlier pain reduction and return to work. Studies^{15–17} comparing the effectiveness of clinic-based and home-based rehabilitation have reported similar findings with regard to pain reduction and improvement in functional status.

Patients must take an active role in rehabilitation, communicate with health care providers, and make necessary behavioral changes. However, current surgical spine care models do not incorporate methods for encouraging patient participation in rehabilitation activities. One method of addressing this challenge is to use health behavior change counseling (HBCC), a brief telephone-based intervention incorporating strategies of motivational interviewing (MI), to improve rehabilitation participation and functional recovery among individuals undergoing spine surgery.¹⁸ Part 1 of our study examined whether a brief MI-based HBCC intervention increased patient participation in PT and/or HEPs, reduced disability, and improved health status after lumbar spine surgery.

Methods

Our institutional review board approved this study, and participants provided informed consent.

Study design

Given the nature of the HBCC intervention, which is integrated into the flow of patient care and directly affects the team's efforts to address the individuals' engagement in their own health and recovery, a lagged-control design was necessary. We had to weigh the benefits of subject randomization against the concerns for contamination across conditions. Given that the intervention involved multiple contact points with the patient and a high likelihood that other staff and surgeons would be aware of the treatment condition, we elected to use a lagged-control design.

Study population

From December 2009 through August 2012, we approached individuals who presented to an academic medical center for surgical treatment of degenerative lumbar spinal stenosis. The surgical treatments offered were lumbar decompression and, for those who presented with lumbar spondylolisthesis, fusion procedures. Patients had to be (1) undergoing surgical care for degenerative conditions (ie, instability or deformity) of the lumbar spine; (2) able to provide informed consent; (3) at least 18 years of age; and (4) English speaking for inclusion in the study. We excluded individuals who had undergone previous spine surgery because they would experience a different course of clinical recovery compared with individuals undergoing primary surgery.¹⁹ Of 139 eligible participants, 14 refused. The first 60 patients were assigned to a control group; the subsequent 65 patients were assigned to the HBCC intervention group. Three patients did not complete postintervention assessment, resulting in a final study group of 122 patients (control group, n=59; HBCC group, n=63).

Initial assessment

All patients in both groups underwent the same initial assessment, as previously described.¹⁸

Demographic and social information

Data on sociodemographic characteristics (age, sex, race/ethnicity) were obtained using a standard patient-completed questionnaire (table 1). The 122 patients were predominantly non-Hispanic white (77%) and women (63%) (mean age $\pm$ SD, 59 $\pm$ 13.3y).¹⁸ Fifty-eight patients (48%) were diagnosed with lumbar stenosis; the remaining patients were diagnosed with lumbar stenosis and spondylolisthesis (n=40, 33%) or lumbar deformity (n=24, 20%). There were no significant differences between the control and HBCC groups in terms of sociodemographic characteristics.

Clinical information

Data on comorbid conditions, pain intensity and interference with daily function, disability, and health status were obtained for all patients using patient-reported measures. The burden of comorbid conditions was assessed using the Charlson Comorbidity Index, a well-validated method of risk adjustment for in-hospital complications and mortality.^{20,21} Pain intensity was assessed using an 11-point rating scale (0 [no pain] to 10 [worst possible pain]).²² This scale has proved to be a reliable and valid measure^{23,24} and free of the response error associated with other pain intensity scales when used among individuals aged 65 years.^{25,26} The 7-item pain interference scale measures the degree to which pain

interferes with activities of daily life (0 [does not interfere] to 10 [completely interferes]); it has been shown to be reliable and valid in surgical patients and patients with chronic low back pain.^{27–30} Disability was assessed using the Oswestry Disability Index (ODI), a disease-specific instrument measuring the impact of spinal disorders on 10 aspects of daily living.³¹ The ODI has been shown to have excellent retest reliability and validity.³¹ Health status was defined according to physical and mental components of health and was assessed using the Medical Outcomes Study 12-Item Short-Form Health Survey, version 2 (SF-12v2), which is an abbreviated version of the Medical Outcomes Study 36-Item Short-Form Health Survey that assesses physical and emotional limitations on work and social activities.³² The SF-12v2 generates a physical component score (PCS) and a mental component score. It has been shown to be a reliable, valid, and responsive health status measure in many patient populations.^{32,33} Previous research has estimated the minimum clinically important difference (MCID) to be 10 points for the ODI and 5 points for the PCS and mental component score.³⁴

There were no preintervention differences between the control and HBCC groups with respect to current pain (intensity or interference), disability, or mental health status. However, before intervention, patients in the HBCC group reported significantly lower physical health status than those in the control group (mean, 32.7 vs 36.2, respectively; $P=.013$).¹⁸

Control group

Patients in this group did not receive the HBCC intervention. To mimic the additional attention and contact provided to the HBCC group, these individuals were provided standard preoperative education and were contacted via two 30-minute telephone calls after surgery. The first call occurred approximately 3 months after surgery, at the time when patients typically begin rehabilitation. The second call occurred approximately 6 months after surgery. During each call, research staff discussed with the participants their progress after surgery. If participants raised questions, they were directed to speak with their surgeon.

HBCC group

Patients in this group received the HBCC intervention, delivered in a 1-hour telephone call before surgery. This intervention is based on the work of Skolasky^{35,36} and Wegener³⁷ and colleagues, and on the existing literature^{38–40} showing effective interventions using MI principles and skills. In the initial intervention session, the trained interventionist uses MI strategies to increase the participant's (1) perception of the importance of PT or HEP in successful rehabilitation, and (2) confidence to follow through on rehabilitation.

At approximately 3 and 6 months after surgery, research staff contacted the patients to discuss their progress. These booster sessions served to identify engagement barriers and facilitate commitment to engage in adaptive behavior. If participants raised additional questions during this 30-minute call, they were directed to speak with their surgeon.

Postsurgical assessment

We assessed rehabilitation participation after 6 weeks and functional recovery at 3 and 6 months after surgery. Outcome reviewers were unaware of study group assignment.

Rehabilitation participation

The evaluation of patient engagement was based on therapist assessments using the Hopkins Rehabilitation Engagement Rating Scale (HRERS)⁴¹ after the first 6 weeks of PT. The HRERS, a 5-item Likert scale used to rate observations of the patient's behavior during PT, has been used to measure engagement in rehabilitative therapy for individuals undergoing rehabilitation and has been established as a consistent and reliable tool.⁴¹

The evaluation of attendance was based on self-reported assessments collected weekly through the first 6 weeks of rehabilitation.³⁵ This assessment consisted of responses to 2 questions: (1) How many sessions of PT or home exercises were prescribed for you in the past 7 days? and (2) How many sessions of PT or home exercises did you attend in the past 7 days? Participants called an answering machine to record their responses. If no response was recorded, the research staff tried to contact the participant up to 3 times to collect this information. The timeliness of this assessment provided some protection against recall bias. Overall averages for attendance in rehabilitation were computed over the 6-week response period.

Functional recovery

The evaluation of disability was based on self-completion of the ODI. Health status was assessed using the SF-12v2.

Statistical analyses

Comparisons of mean rehabilitation engagement and rehabilitation participation were made between the HBCC and control groups using the Student *t* test. Comparisons of change in health status (defined by change from baseline to the 3- or 6-mo assessment using the ODI and SF-12v2) were made between groups using a general linear model to incorporate significant baseline sociodemographic or clinical characteristics as confounding variables.

Our objective was to estimate the effects of the HBCC intervention on postoperative rehabilitation engagement and functional recovery. To address this objective, the proportions of individuals achieving MCID for the HBCC intervention and control groups were compared using the chi-square test. Changes in disability and health status were included as dependent variables in a path diagram containing direct and indirect effects of the HBCC intervention on functional recovery (fig 1). Direct effects were estimated by the regression coefficients *m* and *n*. Indirect effects were mediated by the influence of the HBCC intervention on rehabilitation engagement and rehabilitation participation, and estimated as the product of the regression coefficients. For example, the indirect effect of the HBCC intervention on functional recovery mediated by rehabilitation engagement (HRERS) would be estimated as *a1*b1*. The proportion of the HBCC intervention effect that was caused by the indirect effect was estimated as the ratio of indirect effect to the sum of direct and all indirect effects in the model. For example, the proportion of effect of the HBCC intervention

on functional recovery mediated by rehabilitation engagement would be estimated as the ratio of $a1*b1$ to the sum of $a1*b1$, $a2*b2$, $a3*b3$, and m .

The mediation model was tested using Zellner's seemingly unrelated regression equations, a generalization of linear regression that uses multiple regression models, with each having its own dependent variable and potentially different sets of exogenous explanatory variables.⁴² Each model can be estimated separately; however, the error terms were assumed to be correlated across the models.⁴³ Model fit was assessed using regression diagnostics.⁴⁴

Group comparisons were performed using SAS, version 9.2.^a The path diagram was assessed using the SUREG procedure in Stata, version 12.^b Significance was set at .05.

Results

Compared with controls, HBCC patients exhibited significantly higher rehabilitation participation (table 2) and significantly better functional outcomes (table 3). At 3 and 6 months, patients in the HBCC group experienced lower disability (ODI: $P=.001$ and $P=.012$, respectively) and higher physical health (PCS: $P=.015$ and $P=.002$, respectively). At 3 months, a greater proportion of patients in the HBCC group (61.2%) experienced an MCID on the PCS compared with patients in the control group (39.3%, $P=.034$), whereas there was no difference in the proportion reaching an MCID on the ODI (18.8% HBCC group vs 21.3% control, $P=.892$). At 6 months, the difference in the proportion experiencing an MCID on the PCS persisted (74.1% HBCC vs 42.3% control, $P<.001$). The difference in the proportion of patients in the HBCC group (43.2%) who experienced an MCID on the ODI compared with patients in the control group (25.1%) approached statistical significance ($P=.057$).

Mediation analysis showed significant direct and indirect effects of the HBCC intervention on functional recovery after surgery. At the 3-month assessment, the HBCC intervention had significant direct effects on disability ($P=.028$) and physical health status ($P=.027$) (table 4). The effect of the HBCC intervention on disability was mediated through rehabilitation engagement–HRERS (indirect effect calculated as $a1*b1$, -7.35). Rehabilitation engagement measured by HRERS accounted for 41.5% of the effect of the HBCC intervention on disability (calculated as the ratio of $a1*b1$ to the sum of all other pathways in fig 1). The effect was further mediated by attendance in PT (indirect effect: $-.779$, 4.4%) and attendance in HEP (indirect effect: $-.322$, 1.8%). The effect of the HBCC intervention on physical health status was mediated through rehabilitation engagement–HRERS (indirect effect: 4.39, 44.6%), attendance in PT (indirect effect: .93, 9.4%), and attendance in HEP (indirect effect: .17, 1.7%). At the 6-month assessment, the HBCC intervention had significant direct effects on disability ($P=.023$) and physical health status ($P=.004$) (see table 4). The effect of the HBCC intervention on disability was mediated through rehabilitation engagement–HRERS (indirect effect: -4.50 , 23.1%), attendance in PT (indirect effect: -2.16 , 11.1%), and attendance in HEP (indirect effect: -1.04 , 5.3%). The effect of the HBCC

^aSAS, version 9.2; SAS Institute, Inc.

^bStata, version 12; Stata Corp.

intervention on physical health status was mediated through rehabilitation engagement–HRERS (indirect effect: 2.12, 18.3%), attendance in PT (indirect effect: 1.12, 9.7%), and attendance in HEP (indirect effect: .37, 3.2%).

Discussion

In designing this intervention study, we hypothesized that an increase in patient activation would be the mechanism through which patient engagement in physical therapy and home exercise programs would be improved. In Part II of this pair of manuscripts, we explored the mediating effect of patient activation on health behavior among patients who underwent surgery for degenerative lumbar spinal stenosis. The purpose of our study was to examine the effect of the HBCC intervention on rehabilitation participation and functional recovery after lumbar spine surgery. We have shown that patients in the HBCC intervention group had significantly higher rehabilitation engagement and rehabilitation participation than did patients in the control group. In addition, HBCC patients experienced significantly greater improvements in disability and physical health status scores at 3 and 6 months than did participants in the control group. Although there was improvement in disability scores among HBCC patients, there was no difference in the proportion of patients achieving MCID between the 2 groups. It is possible that longer follow-up will show a significant difference. On the basis of our mediation analysis, we were able to estimate the direct effect of the HBCC intervention on functional recovery and the indirect effects that were mediated through rehabilitation participation. We showed that the proportion of the effect of HBCC on functional recovery mediated by the intervention's effect on participation in rehabilitation was approximately half at 3 months and nearly one-third at 6 months. Our results further show that a greater proportion of patients in the HBCC group experienced a clinically important improvement in physical health at 3 and 6 months compared with patients in the control group. Although the difference was not significant, there is a suggestion that a greater proportion of patients in the HBCC group also experienced a clinically important reduction in disability at 6 months compared with those in the control group.

This study provides evidence that the HBCC intervention based on MI principles leads to improved rehabilitation participation and functional recovery, and that the effect of the HBCC intervention is, in part, mediated by rehabilitation participation. These findings are reinforced by the literature^{12,14,15,45} that documents the benefit of rehabilitation after lumbar spine surgery.

The improvements in health behavior and functional recovery in our HBCC group may be influenced by improvements in patient activation, which would be consistent with earlier findings of the relationship between patient activation and these measures^{35,36} and the broader literature examining the relationship between patient activation and health behavior^{46,47} and health outcomes.^{48,49} In a study of coaching to improve self-management behavior, Hibbard et al³⁸ showed that tailoring the intervention to an individual's level of patient activation led to improvements in patient activation and clinical indicators. Similarly, an intervention focusing on building question formation skills delivered to patients in a community mental health center led to increased patient activation.⁵⁰

Recently, studies have documented the effectiveness of targeted interventions meant to improve patient activation to encourage patients to adopt healthy behaviors such as increased engagement in rehabilitation. Successful interventions have incorporated strategies to empower patients,⁵¹ sessions to provide education,⁵² and strategies to encourage self-management.⁴⁰ These interventions have shown that improved patient activation leads to increased positive health behaviors across a variety of patient populations. One cross-sectional study⁴⁷ of community-dwelling adults with a variety of chronic diseases showed the relationship between improved patient activation and positive change in disease self-management. Even when the behaviors in question were not performed before the intervention, this relationship was apparent. For behaviors that were already being performed, increased patient activation was associated with maintenance of a high level of the behavior after the intervention.

Study limitations

Our study has limitations that must be taken into account when interpreting the current findings. First, we relied on a lagged-control study design to examine the influence of the HBCC intervention. An alternative design would have involved randomly assigning individuals to control or intervention. However, randomization was thought to provide inadequate protection against contamination given how the HBCC was integrated into patient care. Because the proposed HBCC intervention seeks to change the way health care providers interact with patients, it was deemed difficult to expect health care providers to implement the principles of MI in isolation (ie, treating 1 patient with MI and the next patient without). Second, our sample was drawn from a single academic spine center. This limitation, however, may be ameliorated by the fact that our center comprises both a tertiary care center and an affiliated community hospital. Approximately one-third of our participants were recruited and enrolled at the affiliated community hospital. Third, reliance on patient-reported rehabilitation attendance might lead to bias. However, self-report bias may be mitigated because our findings were similar for measures of attendance and of therapist-rated engagement in PT, which lends confidence in these self-reports.

The study used a single interventionist to deliver the HBCC and education attention control. The primary benefit of this approach is the consistency of intervention delivery across participants. (Variability in intervention can threaten the internal validity of the study.) However, the use of a single interventionist limits the generalizability of the intervention. It is possible that the effect of the intervention may be caused by nonspecific therapeutic factors unique to that individual (eg, interpersonal warmth, empathy) rather than by the HBCC principles and features. Future studies should involve multiple sites to allow for randomization and the use of multiple interventionists to determine whether the results observed here can be replicated and generalized to diverse settings and interventionists.

Conclusions

The HBCC intervention is based on MI principles, an evidence-based style of health behavior change consultation developed to address poor treatment outcomes among chronic drinkers.⁵³ MI is a counseling style designed to assist individuals in increasing their

commitment and internal motivation to engage in a behavior. Within MI, motivation to engage in a behavior is viewed as an alterable condition that can be increased via the supportive, patient-centered counseling interaction. MI has been shown to be effective through dozens of clinical trials^{54–57} in diverse areas of health care behavior.

The current study shows that a telephone-based intervention based on MI principles can effectively increase patient rehabilitation participation and subsequent functional recovery among individuals undergoing lumbar spine surgery. This finding is important, given the clinical relevance of rehabilitation participation and its influence on health outcomes. These results are consistent with those of similar studies^{58,59} of patients with other conditions. Furthermore, there is strong empirical evidence showing that a variety of health care professionals with various levels of training can successfully learn MI counseling via 1- to 2-day training workshops,⁶⁰ suggesting that the brief intervention could be scalable and sustainable.

These findings have implications for clinical practice. Patients who are candidates for surgical intervention of degenerative lumbar spine disease have often experienced unsuccessful courses of nonoperative therapy. These experiences may lead to reduced engagement in postoperative PT and home exercise—critical components of recovery. The HBCC intervention provides a brief and effective way to support these patients. Wider use of the HBCC intervention may lead to increased rehabilitation engagement, helping to improve outcomes not only for lumbar spine surgery but for other conditions where rehabilitation is a key part of recovery.

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List of abbreviations:

HBCC	health behavior change counseling
HEP	home exercise program
HRERS	Hopkins Rehabilitation Engagement Rating Scale
MCID	minimum clinically important difference
MI	motivational interviewing
ODI	Oswestry Disability Index
PCS	physical component score
PT	physical therapy
SF-12v2	Medical Outcomes Study 12-Item Short-Form Health Survey, version 2

References

1. Davis H Increasing rates of cervical and lumbar spine surgery in the United States, 1979–1990. *Spine (Phila Pa 1976)* 1994;19: 1117–23. [PubMed: 8059266]
2. Deyo RA, Gray DT, Kreuter W, et al. United States trends in lumbar fusion surgery for degenerative conditions. *Spine (Phila Pa 1976)* 2005;30:1441–5. [PubMed: 15959375]
3. Skolasky RL, Maggard AM, Thorpe RJ, Jr, et al. United States hospital admissions for lumbar spinal stenosis: racial and ethnic differences, 2000 through 2009. *Spine (Phila Pa 1976)* 2013;38:2272–8. [PubMed: 23873234]
4. Weinstein JN, Lurie JD, Olson PR, et al. United States' trends and regional variations in lumbar spine surgery: 1992–2003. *Spine (Phila Pa 1976)* 2006;31:2707–14. [PubMed: 17077740]
5. Jansson KA, Nemeth G, Granath F, et al. Health-related quality of life (EQ-5D) before and one year after surgery for lumbar spinal stenosis. *J Bone Joint Surg Br* 2009;91:210–6. [PubMed: 19190056]
6. Mannion AF, Caporaso F, Pulkovski N, et al. Goal attainment scaling as a measure of treatment success after physiotherapy for chronic low back pain. *Rheumatology (Oxford)* 2010;49:1734–8. [PubMed: 20511346]
7. Lariviere C, Bilodeau M, Forget R, et al. Poor back muscle endurance is related to pain catastrophizing in patients with chronic low back pain. *Spine (Phila Pa 1976)* 2010;35:E1178–86. [PubMed: 20881658]
8. Verbunt JA, Seelen HA, Vlaeyen JW, et al. Fear of injury and physical deconditioning in patients with chronic low back pain. *Arch Phys Med Rehabil* 2003;84:1227–32. [PubMed: 12917865]
9. Verbunt JA, Sieben JM, Seelen HA, et al. Decline in physical activity, disability and pain-related fear in sub-acute low back pain. *Eur J Pain* 2005;9:417–25. [PubMed: 15979022]
10. Greiner-Perth R, Bohm H, Allam Y. A new technique for the treatment of lumbar far lateral disc herniation: technical note and preliminary results. *Eur Spine J* 2003;12:320–4. [PubMed: 12800006]
11. Oosterhuis T, Costa LO, Maher CG, et al. Rehabilitation after lumbar disc surgery. *Cochrane Database Syst Rev* 2014;3:CD003007.
12. Danielsen JM, Johnsen R, Kibsgaard SK, et al. Early aggressive exercise for postoperative rehabilitation after discectomy. *Spine (Phila Pa 1976)* 2000;25:1015–20. [PubMed: 10767815]
13. Filiz M, Cakmak A, Ozcan E. The effectiveness of exercise programmes after lumbar disc surgery: a randomized controlled study. *Clin Rehabil* 2005;19:4–11. [PubMed: 15704503]
14. Manniche C, Skall HF, Braendholt L, et al. Clinical trial of postoperative dynamic back exercises after first lumbar discectomy. *Spine (Phila Pa 1976)* 1993;18:92–7. [PubMed: 8434331]
15. Johannsen F, Remvig L, Kryger P, et al. Supervised endurance exercise training compared to home training after first lumbar discectomy: a clinical trial. *Clin Exp Rheumatol* 1994;12:609–14. [PubMed: 7895394]
16. Johansson AC, Linton SJ, Bergkvist L, et al. Clinic-based training in comparison to home-based training after first-time lumbar disc surgery: a randomised controlled trial. *Eur Spine J* 2009;18:398–409. [PubMed: 19020904]
17. Yilmaz F, Yilmaz A, Merdol F, et al. Efficacy of dynamic lumbar stabilization exercise in lumbar microdiscectomy. *J Rehabil Med* 2003;35:163–7. [PubMed: 12892241]
18. Skolasky RL, Riley LH III, Maggard AM, et al. Functional recovery in lumbar spine surgery: a controlled trial of health behavior change counseling to improve outcomes. *Contemp Clin Trials* 2013;36:207–17. [PubMed: 23816487]
19. Eichholz KM, Ryken TC. Complications of revision spinal surgery. *Neurosurg Focus* 2003;15:E1–4.
20. Deyo RA, Cherkin DC, Ciol MA. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *J Clin Epidemiol* 1992;45:613–9. [PubMed: 1607900]
21. O'Connell RL, Lim LL. Utility of the Charlson comorbidity index computed from routinely collected hospital discharge diagnosis codes. *Methods Inf Med* 2000;39:7–11. [PubMed: 10786063]

22. Downie WW, Leatham PA, Rhind VM, et al. Studies with pain rating scales. *Ann Rheum Dis* 1978;37:378–81. [PubMed: 686873]
23. Breivik EK, Bjornsson GA, Skovlund E. A comparison of pain rating scales by sampling from clinical trial data. *Clin J Pain* 2000;16:22–8. [PubMed: 10741815]
24. Flaherty SA. Pain measurement tools for clinical practice and research. *AANA J* 1996;64:133–40. [PubMed: 9095685]
25. Gagliese L, Weizblit N, Ellis W, et al. The measurement of postoperative pain: a comparison of intensity scales in younger and older surgical patients. *Pain* 2005;117:412–20. [PubMed: 16153776]
26. Herr KA, Spratt K, Mobily PR, et al. Pain intensity assessment in older adults: use of experimental pain to compare psychometric properties and usability of selected pain scales with younger adults. *Clin J Pain* 2004;20:207–19. [PubMed: 15218405]
27. Ballard N, Robley L, Barrett D, et al. Patients' recollections of therapeutic paralysis in the intensive care unit. *Am J Crit Care* 2006; 15:86–94. quiz 95. [PubMed: 16391318]
28. Cleeland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. *Ann Acad Med Singapore* 1994;23:129–38. [PubMed: 8080219]
29. Keller S, Bann CM, Dodd SL, et al. Validity of the Brief Pain Inventory for use in documenting the outcomes of patients with non-cancer pain. *Clin J Pain* 2004;20:309–18. [PubMed: 15322437]
30. Mendoza T, Mayne T, Rublee D, et al. Reliability and validity of a modified Brief Pain Inventory short form in patients with osteoarthritis. *Eur J Pain* 2006;10:353–61. [PubMed: 16051509]
31. Fairbank J Use of Oswestry Disability Index (ODI) [letter]. *Spine (Phila Pa 1976)* 1995;20:1535–6. [PubMed: 8623078]
32. Hurst NP, Ruta DA, Kind P. Comparison of the MOS Short Form-12 (SF12) health status questionnaire with the SF36 in patients with rheumatoid arthritis. *Br J Rheumatol* 1998;37:862–9. [PubMed: 9734677]
33. King JT, Jr, Horowitz MB, Kassam AB, et al. The Short Form-12 and the measurement of health status in patients with cerebral aneurysms: performance, validity, and reliability. *J Neurosurg* 2005;102:489–94. [PubMed: 15796384]
34. Copay AG, Glassman SD, Subach BR, et al. Minimum clinically important difference in lumbar spine surgery patients: a choice of methods using the Oswestry Disability Index, Medical Outcomes Study questionnaire Short Form 36, and pain scales. *Spine J* 2008;8:968–74. [PubMed: 18201937]
35. Skolasky RL, Mackenzie EJ, Wegener ST, et al. Patient activation and adherence to physical therapy in persons undergoing spine surgery. *Spine (Phila Pa 1976)* 2008;33:E784–91. [PubMed: 18827683]
36. Skolasky RL, Mackenzie EJ, Wegener ST, et al. Patient activation and functional recovery in persons undergoing spine surgery. *J Bone Joint Surg Am* 2011;93:1665–71. [PubMed: 21938370]
37. Wegener ST, Mackenzie EJ, Ephraim P, et al. Self-management improves outcomes in persons with limb loss. *Arch Phys Med Rehabil* 2009;90:373–80. [PubMed: 19254599]
38. Hibbard JH, Greene J, Tusler M. Improving the outcomes of disease management by tailoring care to the patient's level of activation. *Am J Manag Care* 2009;15:353–60. [PubMed: 19514801]
39. Linden A, Butterworth SW, Prochaska JO. Motivational interviewing-based health coaching as a chronic care intervention. *J Eval Clin Pract* 2010;16:166–74. [PubMed: 20367828]
40. Williams GC, McGregor H, Zeldman A, et al. Promoting glycemic control through diabetes self-management: evaluating a patient activation intervention. *Patient Educ Couns* 2005;56:28–34. [PubMed: 15590220]
41. Kortte KB, Falk LD, Castillo RC, et al. The Hopkins Rehabilitation Engagement Rating Scale: development and psychometric properties. *Arch Phys Med Rehabil* 2007;88:877–84. [PubMed: 17601468]
42. Zellner A An efficient method of estimating seemingly unrelated regressions and tests for aggregation bias. *J Am Stat Assoc* 1962;57: 348–68.
43. Imai K, Keele L, Tingley D. A general approach to causal mediation analysis. *Psychol Methods* 2010;15:309–34. [PubMed: 20954780]

44. Weisberg S, editor. Applied linear regression. 3rd ed. Hoboken: John Wiley & Sons; 2005.
45. Ostelo RW, Costa LO, Maher CG, et al. Rehabilitation after lumbar disc surgery: an update Cochrane review. *Spine (Phila Pa 1976)* 2009;34:1839–48. [PubMed: 19602996]
46. Harvey L, Fowles JB, Xi M, et al. When activation changes, what else changes? The relationship between change in Patient Activation Measure (PAM) and employees' health status and health behaviors. *Patient Educ Couns* 2012;88:338–43. [PubMed: 22459636]
47. Hibbard JH, Mahoney ER, Stock R, et al. Do increases in patient activation result in improved self-management behaviors? *Health Serv Res* 2007;42:1443–63. [PubMed: 17610432]
48. Greene J, Hibbard JH. Why does patient activation matter? An examination of the relationships between patient activation and health-related outcomes. *J Gen Intern Med* 2012;27:520–6. [PubMed: 22127797]
49. Hibbard JH, Greene J. What the evidence shows about patient activation: better health outcomes and care experiences; fewer data on costs. *Health Aff (Millwood)* 2013;32:207–14. [PubMed: 23381511]
50. Deen D, Lu WH, Rothstein D, et al. Asking questions: the effect of a brief intervention in community health centers on patient activation. *Patient Educ Couns* 2011;84:257–60. [PubMed: 20800414]
51. Alegria M, Polo A, Gao S, et al. Evaluation of a patient activation and empowerment intervention in mental health care. *Med Care* 2008;46:247–56. [PubMed: 18388839]
52. Morisky DE, Bowler MH, Finlay JS. An educational and behavioral approach toward increasing patient activation in hypertension management. *J Community Health* 1982;7:171–82. [PubMed: 7076881]
53. Miller WR, Rollnick S. Motivational interviewing Preparing people for change. 2nd ed. New York: Guilford Pr; 2002.
54. Harland J, White M, Drinkwater C, et al. The Newcastle exercise project: a randomised controlled trial of methods to promote physical activity in primary care. *BMJ* 1999;319:828–32. [PubMed: 10496829]
55. Rollnick S, Butler CC, Stott N. Helping smokers make decisions: the enhancement of brief intervention for general medical practice. *Patient Educ Couns* 1997;31:191–203. [PubMed: 9277242]
56. Project MATCH Research Group. Matching alcoholism treatments to client heterogeneity: treatment main effects and matching effects on drinking during treatment. *J Stud Alcohol* 1998;59:631–9. [PubMed: 9811084]
57. Smith DE, Heckemeyer CM, Kratt PP, et al. Motivational interviewing to improve adherence to a behavioral weight-control program for older obese women with NIDDM. A pilot study. *Diabetes Care* 1997;20:52–4. [PubMed: 9028693]
58. Bell KR, Temkin NR, Esselman PC, et al. The effect of a scheduled telephone intervention on outcome after moderate to severe traumatic brain injury: a randomized trial. *Arch Phys Med Rehabil* 2005;86:851–6. [PubMed: 15895327]
59. Bombardier CH, Cunniffe M, Wadhvani R, et al. The efficacy of telephone counseling for health promotion in people with multiple sclerosis: a randomized controlled trial. *Arch Phys Med Rehabil* 2008;89:1849–56. [PubMed: 18929012]
60. Miller WR, Yahne CE, Moyers TB, et al. A randomized trial of methods to help clinicians learn motivational interviewing. *J Consult Clin Psychol* 2004;72:1050–62. [PubMed: 15612851]

Fig 1.

Path diagram for a hypothesized model predicting functional recovery at the 3-month assessment after lumbar spine surgery. This same model was used to predict functional recovery at the 6-month assessment. Abbreviations: a, indirect pathway for the influence of HBCC on PT/HEP engagement; att HEP, self-reported attendance in home exercise program; att PT, self-reported attendance in physical therapy; b, indirect pathway for the influence of PT/HEP engagement on disability at 3 months; c, indirect pathway for the influence of PT/HEP engagement on physical health at 3 months; m, direct pathway for the influence of HBCC on disability at 3 months; n, direct pathway for the influence of HBCC on physical health at 3 months.

Table 1

Baseline characteristics of participants

Characteristic	Overall (N = 122)	Control Group (n = 59)	Intervention Group (n = 63)	P*
Age (y)	59.0±13.3	58.1±13.5	59.9±13.2	.449
Women	77 (63.1)	39 (66.1)	38 (60.3)	.508
Race				
White	94 (77.1)	45 (76.3)	49 (77.8)	.328
Black	23 (18.9)	13 (22.0)	10 (15.9)	
Other	5 (4.1)	1 (1.7)	4 (6.4)	
Ethnicity				
Hispanic	6 (4.9)	1 (1.7)	5 (7.9)	.111
Non-Hispanic	116 (95.1)	58 (98.3)	58 (92.1)	
Spine disorder				
LS	58 (47.5)	29 (49.2)	29 (46.0)	.874
LS and spondylolisthesis	40 (32.8)	18 (30.5)	22 (34.9)	
Lumbar deformity	24 (19.7)	12 (20.3)	12 (19.0)	

NOTE. Values are mean ± SD, n (%), or as otherwise indicated.

Abbreviation: LS, lumbar stenosis.

* Comparison of control (standard care) and intervention (HBCC) groups.

Table 2

Participation in rehabilitation, overall and stratified by study group

Measure	Overall (N = 122)	Control Group (n = 59)	HBCC Group (n = 63)	P
Rehabilitation engagement [*]	22.28±3.710	21.20±4.560	23.57±2.710	<.001
PT attendance [†]	0.730±0.213	0.667±0.208	0.822±0.160	<.001
HEP attendance [†]	0.669±0.223	0.653±0.227	0.753±0.216	.019

NOTE. Values are mean ± SD or as otherwise indicated.

^{*} Reported by physical therapists using the HRERS.[†] Reported by patients.

Table 3

Functional outcomes, overall and stratified by study group

Measure	Overall (N = 122)		Control Group (n = 59)		HBCC Group (n = 63)	
	3mo	6mo	3mo	6mo	3mo	6mo
Disability (ODI) *	33.15±16.57	32.38±16.79	36.45±17.98	34.92±16.49	29.06±13.74	27.77±16.56
Health status [†]						
Physical health (PCS)	48.35±8.12	52.78±7.77	46.68±7.92	51.63±6.83	51.65±7.16	54.87±8.10
Mental health (MCS)	47.05±9.97	43.97±10.37	48.24±10.07	43.62±10.28	45.56±9.74	44.61±10.71

NOTE. Values are mean ± SE. Analyses adjusted by patient age, sex, type of spine disorder, type of surgical intervention, and preoperative measure.

Abbreviation: MCS, mental component score.

* Disability was assessed using the ODI, version 2.

[†] Health status was assessed using the SF-12v2.

Table 4

Direct and indirect effects of HBCC intervention on functional recovery

Dependent Variable by Time Point	Significant Mediation Path*	Estimate (SE)	P
3 Months			
Health behavior	<i>a1</i> . HBCC → HRERS	1.860 (0.70)	.008
	<i>a2</i> . HBCC → att PT	0.191 (0.034)	<.001
	<i>a3</i> . HBCC → att HEP	0.068 (0.043)	.110
Disability	<i>b1</i> . HRERS → ODI	-3.950 (1.39)	.005
	<i>b2</i> . att PT → ODI	-4.080 (1.16)	<.001
	<i>b3</i> . att HEP → ODI	-4.730 (2.18)	.030
	<i>m</i> . HBCC → ODI	-9.280 (4.21)	.028
Physical health	<i>c1</i> . HRERS → PCS	2.360 (1.05)	.025
	<i>c2</i> . att PT → PCS	4.870 (2.32)	.037
	<i>c3</i> . att HEP → PCS	2.510 (3.82)	.511
	<i>n</i> . HBCC → PCS	4.360 (1.97)	.027
6 Months			
Health behavior	<i>a1</i> . HBCC → HRERS	1.750 (0.87)	.044
	<i>a2</i> . HBCC → att PT	0.198 (0.038)	<.001
	<i>a3</i> . HBCC → att HEP	0.074 (0.034)	.178
Disability	<i>b1</i> . HRERS → ODI	-2.570 (1.28)	.045
	<i>b2</i> . att PT → ODI	-10.930 (6.03)	.070
	<i>b3</i> . att HEP → ODI	-14.030 (9.36)	.134
	<i>m</i> . HBCC → ODI	-11.770 (5.17)	.023
Physical health	<i>c1</i> . HRERS → PCS	1.210 (0.48)	.012
	<i>c2</i> . att PT → PCS	5.660 (5.31)	.286
	<i>c3</i> . att HEP → PCS	4.960 (5.03)	.324
	<i>n</i> . HBCC → PCS	7.960 (2.79)	.004

Abbreviations: att HEP, self-reported attendance in home exercise program; att PT, self-reported attendance in physical therapy.

* *m* and *n* are the direct pathways, and *a1*, *a2*, etc, are the indirect pathways for the influence of HBCC on disability and physical health at 3 and 6 months (see pathways on fig 1).