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The Impact of Self-Management Knowledge and Support on the Relationship between Self-Efficacy, Patient Activation and Self-Management in Rural Heart Failure Patients

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Introduction

Effective self-management (SM) is an essential component of comprehensive disease management of patients with heart failure (HF),¹ which prevents adverse outcomes (e.g., mortality, complications),^{2,3} reduces hospital readmission,⁴ and improves functioning and independence.⁵ However, patients with HF often fail to routinely perform SM behaviors,^{1,6} and those living in rural settings may be less likely to engage in SM behaviors.⁷

Based on Bandura's social cognitive theory (SCT),⁸ the common central mechanism of previous SM interventions is self-efficacy. Supported by observational studies,^{4,9–11} increased self-efficacy results in the improvement in SM behaviors. However, experimental studies have not demonstrated that increased knowledge and self-efficacy lead to increased SM behaviors in HF patients^{1,7,12}

In order to address these contradictions in the evidence, researchers are examining additional intervention mechanisms, used alone or in combination, that may improve HF patients' SM behaviors. Recently, investigators have reported the positive association between patient activation and SM behaviors in populations with various chronic conditions (e.g., heart failure,¹³ heart disease,¹⁴ hypertension,¹⁵ and diabetes¹⁶). Patient activation, the central concept in Wagner's chronic illness care model,¹⁷ is defined by Hibbard as the degree to which the person is ready, willing, and able to engage in health behavior change and manage his/her own health.¹⁸ In current literature, however, there is little evidence about the interaction between self-efficacy and patient activation on HF patients' SM behaviors.

Previously, we found that patient activation mediated the effect of self-efficacy on SM behaviors, using baseline data collected from a randomized control trial (RCT).¹⁹ This study examined whether the mediation pathway remains at 3 months following the intervention. Moreover, investigators have reported that the factors associated with high levels of activation for SM, both within the general population and for those living with multiple

chronic conditions, were female gender,²⁰ younger age,²¹ higher level of education,²¹ greater self-care knowledge and support,²² adequate physical functioning,²¹ and lower disease severity (including both primary disease and comorbidities).^{23,24} Whether these factors impact the mediation pathway between self-efficacy, patient activation, and SM behaviors in HF patients is unknown. Therefore, we explored moderators of the mediation pathway in order to establish for whom the mediating effects of patient activation were strongest. Without a clear understanding of the mechanisms influencing SM behavior, it is impossible to develop effective interventions to promote SM behaviors. Therefore, the overall purpose of this study was to examine the moderating effects of SM knowledge and support on the relationships among self-efficacy, patient activation and SM behavior in rural HF patients who participated in a RCT aimed to promote SM behaviors.

Methods

Study design

This was a secondary analysis, using the data collected from a RCT, entitled “Patient ActiVated Care at Home (PATCH).” The trial was intended to examine the feasibility and efficacy of a 12-week home-based intervention to improve SM behaviors in HF patients.²⁵ The study was approved by the university institutional review board and the hospital ethical committees. All subjects provided written informed consent. Details regarding intervention content and intervention administration were previously reported.²⁵

Sample and setting

Subjects were recruited from a rural hospital in Southeast Nebraska. The included subjects: 1) were 21 years or older; 2) had a discharge diagnosis of HF; 3) were classified New York Heart Association (NYHA) class I with at least one HF-related hospitalization or emergency department visit in the previous year; 4) were classified NYHA class II to IV; 5) were discharged to home; 6) were able to achieve a score of 3 or greater on the Mini-Cog™ test, a validated screening test for dementia in population based sample;²⁶ 7) understood and spoke English; and 8) had access to phone. We excluded patients who were diagnosed with: 1) depression; 2) cirrhosis; 3) chronic renal failure; and 4) other end stage and/or terminal illness (e.g. cancer) which limited the patient's SM capacity.²⁵ With the exception of the Mini-Cog™ test, all other clinical diagnoses (e.g., NYHA, depression, cirrhosis, chronic renal failure, or terminal illness) were collected and confirmed from patients' medical records in hospital, primary care, and specialty clinics. We were unable to obtain the effect size from similar studies in comparable populations or from a pilot study. Therefore, a power analysis was conducted based on a medium effect correlation of $r = 0.3$.²⁷ Using a two sided test, 5% significance level ($\alpha=0.05$) with 80% power, the required sample size was approximately 98 ($n=98$).²⁸

Measures

A battery of measures was administered at 3-month intervals (baseline, 3-, and 6-months after intervention).

Variables and measures for mediation analysis

The Self-care of HF Index (SCHFI) Subscale C (i.e., self-care confidence scale) was used to assess **Self-efficacy for SM**. The conceptual framework supporting our intervention design was built upon Wagner's Chronic Care Model that emphasizes the impacts of patients' knowledge, confidence, and activation level on SM.²⁹ The SCHFI was designed to evaluate intervention effects on self-efficacy and activation level, which is congruent with the intervention mechanisms supported by Bandura's work.^{8,29,30} The SCHFI self-care confidence scale is a self-report 6-item measure.³⁰ Items are rated on a 4-point Likert scale. Scores are standardized to range from 0 to 100, with higher scores indicating higher self-efficacy. SCHFI has shown good psychometric properties, with high reliability in the HF population ($\alpha = 0.827$).³⁰ There was also a significant correlation between self-efficacy and SM in HF patients ($r = 0.42$).³⁰

Patient activation was assessed by the Patient Activation Measure (PAM) with 13 items.³¹ Each item is rated on a 5-point Likert scale. The score ranges from 0 to 100, with higher scores indicating higher activation levels. PAM demonstrated high internal consistency (Cronbach alpha = 0.87) and construct validity, as evidenced by significant associations with levels of physical activity, medication adherence, health status, and quality of healthcare.^{24,31} PAM has been tested in various populations living with chronic complex conditions (e.g., multiple sclerosis, arthritis, heart disease, and diabetes).^{24,32}

Heart failure self-management (SM) behaviors were assessed by the 29-item Revised Heart Failure Self-Care Behavior Scale (RHFSCBS).³³ Each response was rated on a 5-point Likert scale (0= none of the time, 5= all of the time).³³ The internal reliability of this questionnaire is demonstrated by a Cronbach alpha level of 84.³³

Variables and measures for moderation analysis

The data on moderators were collected from medical records (e.g., gender, age, and education level), the questionnaires (e.g., SM knowledge and support) and physiology devices (e.g., physical functioning).

SM knowledge was measured by a 7-item Heart Failure Management Knowledge questionnaire with a 10-point Likert scale and reported reliability (Cronbach's alpha=0.75).³⁴ Higher scores indicated greater SM knowledge.³⁴

SM support was assessed by Medication Adherence in Heart Failure Patients, Section 4 (Subjective Norm) subscale.³⁴ This is a 4-item, 5-point Likert questionnaire with acceptable reliability (item-total correlations = 0.52–0.67).³⁴ This measure assessed the patients' perceived self-care support from their family members and healthcare professionals. The scores ranged from 4 to 40, and higher scores indicated the greater perceived SM support from family and healthcare providers.³⁴

Physical functioning was assessed by waist-worn accelerometer, an Actigraph GT3X-BT (Actigraph, Pensacola, Florida, USA). The data were collected at baseline, 3 and 6 months after intervention. Actigraph data included calories expended in activity, activity counts, and

minutes in moderate or greater intensity physical activity. Minutes in moderate or greater intensity physical activity were used to assess subjects' physical functioning.

Renal function (i.e., serum creatinine [Cr], glomerular filtration rate [GFR], and blood urea nitrogen [BUN]) was used as the proxy measure of HF severity because renal dysfunction is an independent indicator of disease severity and poor prognosis in HF patients with comorbidities.³⁷ The reduced renal function measured by increased Cr, BUN, and reduced GFR indicated the worse HF.³⁷ Renal function profiles were assessed at baseline, 3, and 6 months after intervention.

Data Analysis

Statistical analyses were conducted using IBM SPSS 22, with $p < .05$ considered significant.³⁸ The mediation and moderation models were estimated using M-Plus Version 7 with full information maximum likelihood (FIML) in which the estimates are not biased by missing data.^{39,40} The normality assumption was tested and verified via histograms and Shapiro-Wilk tests prior to conducting the path analysis.⁴¹ Descriptive statistics (mean and standard deviation [SD] for continuous data, frequency, and percentage for categorical data) were computed for demographic and clinical variables. Pearson correlations and linear regressions were used to identify relationships among the variables of interest. Path analysis with maximum likelihood was used to test for mediation among self-efficacy, patient activation, and SM behaviors. Mediation was assessed following the guidelines provided by Barron and Kenney,⁴² which require a direct effect to first be present, then an effect of the independent variable on the mediator and the mediator on the outcome. Finally, if mediation exists, the direct effect is no longer significant after accounting for the mediator. For moderation analysis, multiple linear regressions were used first to test the presence of moderating relationships, then the moderating effects were interpreted in the context of the path model by a median split of the sample based on the moderator. Although age was found to be related to self-efficacy, neither age nor gender were related to any of the outcome variables in these analyses, so no covariates were included in the models.

Results

Sample characteristics

The final sample used for analysis included 100 subjects (64 females and 36 males). Participant summary demographic and clinical characteristics are presented in Table 1. Participant mean age was 70.2 (± 12.21) years. Most subjects were white (95%), retired (71%), women (64%), and had an average of 12.9 (± 2.3) years of education. A total of 50% of them lived with someone. Clinically, most subjects' cardiac functioning was classified at New York Heart Association (NYHA) level II (49%) or III (42%) with preserved ejection fraction (55.7 ± 11.1). The majority of subjects were overweight or obese, with an average BMI of 32.3 (± 7.1). On average, subjects had 8 (± 2.6) comorbidities, including hypertension (99%), coronary artery disease (94%), arthritis or degenerative joint disease (89%), and hypercholesterolemia (84%). Subjects reported taking an average of 16.2 (± 8.8) pills per day. At baseline, the subjects in both intervention and control groups had low scores in self-efficacy, activation, and engaging self-management (Table 1).

Results of mediation analysis

Bivariate correlations showed significant relationships among the variables of interest. Among HF patients at 3 months post-intervention, self-efficacy for SM was positively related to patient activation ($r = .712, p < 0.001$) and SM behaviors ($r = .46, p < 0.001$), respectively. Patient activation was significantly associated with SM behaviors ($r = .528, p < 0.001$) (Table 2). Path analysis showed that patient activation mediated the effect of self-efficacy on SM in HF patients discharged from the rural hospital. Significant mediation effects are represented in Figure 1. First, patients with greater self-efficacy were more likely to engage in SM behaviors ($r = .46, p < .001$). Second, self-efficacy for SM had a significant association with patient activation ($\beta = .747, p < .001$). Third, patient activation was significantly related to the SM behaviors ($\beta = .48, p = .001$). In the final step, self-efficacy was no longer directly related to SM behaviors when patient activation was entered into the model ($\beta = .17, p = .248$). These findings suggest that self-efficacy for SM led to changes in patient activation which, in turn, led to subsequent changes in SM behaviors at 3 months.

Results of moderation analysis

Bivariate correlations showed that the factors related to both baseline and 3-month patient activation scores were education level, physical functioning, SM knowledge, and support. Patients who had less disease severity and received the 12-week activation-enhancing intervention had significantly greater patient activation scores at 3 months. Gender and age were not associated with patient activation (Table 3). Moderation analysis showed that only SM knowledge and support had significant moderating effects on the relationships between self-efficacy, patient activation, and SM behaviors. SM knowledge significantly reduced the strength of the relationships between self-efficacy and SM behavior, as well as the relationship between patient activation and SM behavior (Table 4). The follow-up multiple group analysis showed a significant mediating effect of patient activation between self-efficacy and SM behaviors at low levels of SM knowledge ($\beta=0.59, p = 0.006$). In patients with high levels of SM knowledge, patient activation did not mediate the effect of self-efficacy on SM behaviors ($\beta=0.15, p = 0.47$). In patients with low levels of SM support, less confident patients were less likely to engage in SM behaviors ($\beta=0.55, p = 0.002$). In HF patients with high levels of SM support, the impact of self-efficacy on SM behaviors was no longer significant ($\beta= -0.02, p = 0.928$). Furthermore, when SM support was entered in the path model, patient activation was not a significant mediator between self-efficacy and SM behavior at high ($\beta=0.27, p = 0.27$) or low ($\beta=0.27, p = 0.25$) levels of SM support (Table 5).

Discussion

Consistent with our previous findings on baseline data of the parent RCT,¹⁹ patient activation remained a mediator of the relationship between self-efficacy and SM behavior in rural HF patients at 3 months of intervention. We further tested several evidence-based moderators,^{20,21,21,21–24} and found SM knowledge and support were significant moderators of the relationship between self-efficacy, patient activation, and SM behaviors. In HF patients with low levels of SM knowledge, levels of self-efficacy had a positive impact on SM behavior through patient activation. However, in HF patients with high levels of SM knowledge, neither self-efficacy nor patient activation significantly accounted for SM

behavioral changes (Figure 1). Studies of the relationship between knowledge, self-efficacy, and SM behaviors have produced inconsistent findings.^{9,10,47} A number of investigators have reported that improved knowledge or confidence did not necessarily lead to enhanced SM behaviors in HF patients,^{1,47} while others found a significant impact of confidence (self-efficacy) and knowledge on SM behaviors by HF patients.⁴⁸ Our study results may explain the inconsistency between study findings. The varied level of SM knowledge in participants across different studies might impact the strength of relationship between self-efficacy and SM behaviors.

Similar to others' findings,^{43,44} we also found the interaction between SM support and self-efficacy for SM. In patients with low SM support, confident patients (higher self-efficacy) were more likely to engage in SM behaviors than less confident patients. On the other hand, if the patients perceived greater SM support, they were more likely to engage in SM behaviors, regardless of their levels of confidence (self-efficacy) and activation (Figure 1). Studies showed perceived SM support was significantly affected by patients' relationships with their healthcare providers.⁴⁵ A good patient-provider relationship contributed to positive SM support, improved engagement, and higher level of activation in SM behaviors.^{22,46} We previously reported that the participants in our intervention group had significant improvement in SM behaviors. However, the analysis showed the mediating effect of patient activation did not contribute to the group difference in SM behavior at 3 months of intervention. We speculate that the improvement of SM behaviors in the intervention group may be the result of effective patient-provider relationships as they are known to: 1) empower patients' engagement in self-care; 2) promote close supervision and feedback related to SM behavior adherence; 3) promote positive feedback and encouragement; 4) boost effectiveness of counseling and education; and 5) assist in developing effective coping strategies.²²

Limitations

Several limitations exist in this study. First, the use of convenience sampling affects the generalizability of the findings to other HF populations. Second, the small sample size might produce unstable results that need to be verified in a larger sample with a more diverse population before generalizing the results. Third, participant recruitment may have resulted in selection bias. The original study was a randomized controlled trial aimed to improve SM adherence. It is possible that patients who enrolled in this study could be more confident and more actively engaged in SM behaviors than patients who declined. However, the moderating and mediating relationships among variables of interest should be consistent in both enrolled and unenrolled patient groups. In addition, the study included more female subjects, which could also contribute to the selection bias. It has been reported that rural elderly women experienced greater social isolation and mental health issues compared to their urban counterparts,⁴⁹ which may affect the study results. On the other hand, the intervention provided by the original RCT appeared to be feasible and effective to improve SM behaviors and address SM needs in this vulnerable and high risk population. Lastly, the measures of SM knowledge and support were rudimentary and heterogeneous in content, and, therefore, may not adequately capture the complexity of the constructs, which hinders

our ability to pinpoint which subdomain of knowledge and support is affecting SM behaviors the most.

Implications

To our knowledge, this is the first study to examine both mediators and moderators of the relationship between self-efficacy and SM behaviors in HF patients.¹⁹ Findings not only help explain the interrelationships between patient activation and self-efficacy and their combined effect on SM behaviors but also the impact of between-individual variations (moderators) on the relationships between self-efficacy, patient activation, and SM behaviors. The study suggested that the mediating effect of patient activation on self-efficacy and SM behaviors was only significant in rural HF patients with lower levels of SM knowledge. Thus, SM intervention may need target patients with poor or inadequate SM knowledge. Furthermore, the interaction between SM support and self-efficacy suggested the importance to enhance SM support by improving patient-provider relationship when implementing SM interventions. Engagement of patients' primary care team may play a key role to sustain the intervention effect and improve HF patients' SM behavior.

Conclusion

The study findings showed that patient activation mediated the effect of self-efficacy on SM behaviors in rural HF patients with low levels of SM knowledge. Perceived SM support played an important role in SM behaviors. Targeting the intervention to the subpopulation with low SM knowledge and poor support may enhance the effectiveness and efficiency of future interventions. However, before providing definitive recommendations, additional studies using larger and more diverse samples are needed.

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Figure 1.
Moderators and mediators of HF self-management

Table 1

Patient demographic and clinical characteristics

	All (n =100)	Intervention group (n = 51)	Control group (n = 49)
Demographic data			
Age (years)	70.2 ± 12.2	68.7 ± 11.8	71.8 ± 12.6
Male	36 (36)	24 (47.1)	12 (24.5)
Education (years)	12.9 ± 2.3	13 ± 2.4	12.8 ± 2.1
Caucasian	95 (95)	48 (94.1)	47 (95.9)
Provider-patient relationship/living with partner	50 (50)	31 (60.8)	19 (38.8)
Currently employed outside home	29 (29)	16 (30.8)	13 (26.5)
Annual family income (< \$30,000)	51 (51)	24 (47.10)	27 (55.1)
Risk factor profile			
Body Mass Index (kg/m ²)	32.3 ± 7.1	33.4 ± 7.4	31.2 ± 6.8
Clinical data			
Number of comorbidities	8 ± 2.6	7.8 ± 2.5	8.0 ± 2.7
1. Hypertension	99 (99)	51 (100.0)	48 (98.0)
2. Coronary artery disease	94 (94)	46 (90.2)	48 (98)
3. Arthritis degenerative joint disease	89 (89)	43 (84.3)	44 (89.8)
4. Hypercholesterolemia	84 (84)	43 (84.3)	41 (83.7)
5. Diabetes mellitus with or without complications	41 (41)	41 (80.4)	33 (67.4)
6. Dyspepsia	50 (50)	24 (47.1)	26 (53.1)
7. Peripheral vascular disease or lower extremity edema	45 (45)	22 (43.1)	23 (46.9)
8. Chronic obstructive pulmonary disease	38 (38)	22 (43.1)	16 (32.7)
Variables of interest			
Self-efficacy for self-management (0–100)	46.8 (23.8)	44.9 (24.7)	49.2 (22.9)
Patient activation (0–100)	57.02 (18.71)	57.3 (19.2)	56.6 (18.6)
Self-management behaviors (0–145)	89.06 (19.7)	86.8 (19.3)	91.9 (19.9)

Table 2

Descriptive Statistics and Pearson's Correlations Coefficients for the Correlates at 3-months (n = 100)

Correlates	Group	3-month Mean (SD)	Normal Range	SCHFI	PAM	RHFSCBS
Self-efficacy for SM (SCHFI)	PATCH	59.7 (17.3)	0–100	1	0.712 *	0.46 *
	UC	53.8 (24.0)				
Patient activation (PAM)	PATCH	69.1 (16.7)	0–100	--	1	0.528 *
	UC	61.4 (18.2)				
SM behavior (RHFSCBS)	PATCH	115.7 (19.6)	0–145	--	--	1
	UC	97.6 (22.6)				

Note: SM: self-management; SCHFI: Self-care of heart failure index; PATCH: intervention group; UC: usual care group; PAM: patient activation measure; RHFSCBS: revised heart failure self-care behavior scale;

*
p<0.001

Table 3

Proposed moderators and their relationships with baseline, 3-month patient activation measures

Proposed Moderators	Baseline Patient activation <i>r</i> (<i>p</i>)	3-month patient activation <i>r</i> (<i>p</i>)
Gender	.064 (.527)	.071 (.487)
Age	-.138 (.171)	-.186 (.068)
Education level	.237 * (.018)	.297 ** (.003)
Disease severity assessed by renal function	.067 (.511)	.308 ** (.002)
Physical functioning	.231 * (.024)	.270 ** (.008)
SM Knowledge at 3-months	.301 ** (.003)	.484 ** (<.001)
SM support at 3-months	.386 ** (<.001)	.461 ** (<.001)
Received intervention	--	.253 * (.013)

Note:

*
p<0.05;**
p < 0.01

Table 4

Moderating effects of SM knowledge and support at 3 months (n = 100)

Parameter	B	Std. Error	t	p-value
Intercept	56.87	8.96	6.34	.000
Self-Efficacy	0.66	0.18	3.60	.001
Knowledge	2.21	0.58	3.80	.000
Self-Efficacy * Knowledge	-0.02	0.01	-2.51	.014
Intercept	34.27	13.35	2.57	.012
Activation	0.94	0.23	4.13	.000
Knowledge	2.36	0.71	3.35	.001
Activation * Knowledge	-0.03	0.01	-2.36	.020
Intercept	-36.43	37.71	-0.97	.336
Self-Efficacy	2.01	0.66	3.06	.003
Norms	7.20	2.29	3.14	.002
Self-Efficacy * Norms	-0.09	0.04	-2.47	.015

* Note: Three separate models. Dependent variable is Self-Management

Table 5

Multiple group models for interpreting moderating effects

	Low SM knowledge				High SM knowledge			
Paths	Unstd. B	S.E.	Z-test	Std. B	Unstd. B	S.E.	Z-test	Std. B
SE → PAM	0.491 **	0.082	6.015	0.664 **	0.652 **	0.071	9.131	0.543 **
SE → RHFSCB	0.242	0.153	1.579	0.239	-0.057	0.222	-0.259	-0.052
PAM→RHFSCB	0.588 **	0.212	2.771	0.431 **	0.145	0.202	0.719	0.159
	Low SM support				High SM support			
Paths	Unstd. B	S.E.	Z-test	Std. B	Unstd. B	S.E.	Z-test	Std. B
SE → PAM	0.568 **	0.064	8.898	0.747 **	0.508 **	0.090	5.629	0.462 **
SE → RHFSCB	0.550 **	0.177	3.099	0.480 **	-0.020	0.211	-0.096	-0.018
PAM→RHFSCB	0.267	0.231	1.156	0.177	0.271	0.244	1.107	0.265

Note: SE: self-efficacy for self-management; PAM: patient activation measure; RHFSCB: revised heart failure self-care behavior; Unstd.B: unstandardized B; S.E.: standard error; Std.B: standardized B

**
p<0.01