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Interdisciplinary intervention reduced the risk of being persistently depressive among older patients with hip fracture

Ming-Yueh Tseng,[1†] Yea-Ing L Shyu,[2,3†] Jersey Liang[4,5] and Wen-Che Tsai[6,7]

[1]Department of Nursing, MeiHo University, Pingtung, [2]School of Nursing, College of Medicine, [3]Healthy Aging Research Center, Chang Gung University, Taoyuan, [6]Department of Psychiatry, National Taiwan University Hospital, [7]College of Medicine, National Taiwan University, Taipei, [4]School of Public Health, and [5]Institute of Gerontology, University of Michigan, Ann Arbor, Michigan, USA

Aim: To assess the effects of an interdisciplinary intervention on the trajectories of depressive symptoms among older patients during 2 years after hip fracture surgery.

Methods: A secondary analysis of data from a randomized controlled trial that contrasted usual care with an interdisciplinary program. Whereas usual care (n = 77) entailed only in-hospital rehabilitation and occasional discharge planning, the interdisciplinary program (n = 76) consisted of geriatric consultation, in-hospital rehabilitation, discharge planning and rehabilitation at home for 3 months after hospitalization. Depressive symptoms were assessed by using the Chinese version of the Geriatric Depression Scale short-form, before discharge, and 1, 3, 6, 12, 18 and 24 months after discharge. Covariates included demographic attributes, pre-fracture performance of activities of daily living (Chinese Barthel Index) and cognitive functioning (Mini-Mental State Examination).

Results: Changes in depressive symptoms can be characterized by three trajectory groups, including a non-depressive group (n = 58, 37.8%), a marginally depressive group (n = 46, 30.7%) and a persistently depressive group (n = 49, 31.5%). Relative to those who received usual care, participants in the interdisciplinary program had a significantly lower risk of being in the persistently depressive group (odds ratio 0.23, $P < 0.05$). In addition, women and those physically and cognitively more impaired were more likely to be in the marginally and persistently depressive groups.

Conclusions: Our interdisciplinary intervention reduced older persons' likelihood of having persistent depressive symptoms after hip fracture surgery. **Geriatr Gerontol Int 2016; 16: 1145–1152.**

Keywords: depressive symptoms, hip fracture elders, interdisciplinary intervention, randomized controlled trial.

Introduction

Depression after hip fracture surgery is known to negatively impact older patients' recovery[1,2] and rehabilitation outcomes.[3] In addition, it increases the risk of mortality.[4–6] Among older patients with hip fracture in Western developed nations, the prevalence of depression ranges from 9% to 47%, mostly within 3 months after discharge.[7,8] According to two randomized controlled trials of older adults after surgery for hip fracture, no statistically significant benefits can be achieved from a psychiatric intervention in people who are depressed or a psychological intervention to prevent the onset of depression.[9]

This lack of significant intervention benefits might have been due to the focus on the average course of change in depressive symptoms after hip fracture.[9] Because several trajectories of depressive symptoms might exist among patients with hip fracture, the effects of the intervention could vary across these trajectories. Such heterogeneity is supported by recent reports of multiple trajectories of depressive symptoms in older persons.[10–12] Based on data from a national sample of Americans aged 50 years or older over a period of 10

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Correspondence: Professor Jersey Liang PhD, School of Public Health, University of Michigan, 1420 Washington Heights, SPH II M3007 Ann Arbor, MI 48109-2029, USA. Email: jliang@umich.edu
†Contributed equally to this work.

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years, Liang *et al*. identified six trajectories of depressive symptoms: (i) minimal depressive symptoms; (ii) low depressive symptoms; (iii) moderate and stable depressive symptoms; (iv) high but decreasing depressive symptoms; (v) moderate but increasing depressive symptoms; and (vi) persistently high depressive symptoms.[12]

In most studies of depressive symptoms among older adults with hip fracture, the focus was on the average change of depressive symptoms over time and how individuals deviate from this average. Nevertheless, changes in depressive symptoms can vary substantially, with some individuals experiencing declines or improvements in symptomatology over time and others remaining at stable levels of symptoms.[10,12] As a result, temporal variations in depressive symptoms can be understood as a number of distinct trajectories. With reference to the effects of an intervention in better managing hip fracture among older patients, at least two important research issues remain to be addressed. First, what are the distinct trajectories of depressive symptoms over time, if any, among older patients with hip fracture? Second, how does the intervention affect the probability that a patient will follow a certain trajectory of depressive symptoms?

In an earlier study by the present authors, we found that the interdisciplinary intervention for hip fracture benefited elderly persons with hip fracture by decreasing depressive symptoms, and improving clinical outcomes, self-care ability and physical health-related outcomes during the first 24 months after hospital discharge.[13] This analysis was limited, because it focused on the average course of changes in depressive symptoms without exploring whether depressive symptoms might change along several distinct trajectories. Hence, two research questions remain unanswered: Do multiple distinct trajectories of depressive symptoms exist among patients with hip fracture? If so, what are their levels and rates of change over time like? What are the effects of the interdisciplinary intervention on these distinct courses of changes in depressive symptoms? To address these questions, we carried out the present secondary analysis to identify the distinct courses of change in depressive symptoms over a 2-year period. In addition, we analyzed the effects on these trajectories. In particular, we evaluated the following two hypotheses.

Hypothesis 1 (H_1): Depressive symptoms during the 2 years after hospitalization for hip fracture follow multiple distinct courses or trajectories that can be characterized as persistently depressive, marginally depressive and non-depressive.

Hypothesis 2 (H_2): The interdisciplinary intervention might reduce the odds of being in a moderately high or a persistently high depressive trajectory group over time.

Methods

Study design and participants

Data for this secondary analysis came from a clinical trial on the effectiveness of an interdisciplinary intervention program for older people with hip fracture.[13] In the original study, 162 participants (80 in the experimental group, 82 in the control group) were recruited from September 2001 to November 2004. However, nine participants from the original study (5 in the control group and 4 in the experimental group) were excluded because they lacked at least one assessment of depressive symptoms (Geriatric Depression Scale short-form [GDS-s]). All participants were assessed before discharge, and at 1, 3, 6, 12, 18 and 24 months after discharge. At the end of 2 years, 55 and 48 participants remained in the experimental and control groups, respectively. In particular, during the 2-year period of observation, nine participants in the experimental group died and 12 refused to remain in the trial. In the control group, 13 participants died, whereas 16 dropped out because of refusal to continue participation. The response rates at each evaluation point were 94.8–75.7% (Table 1). Data collected from these individuals were nevertheless included in our analysis on the basis of the assumption of missing at random. In addition, mortality and attrition did not significantly differ between the experimental and control groups (Table 2). As a result, selection bias is unlikely to be an issue.

In the original study, patients were included if they met these criteria: (i) aged 60 years or older; (ii) admitted

Table 1 Response rate to follow-up surveys

Time (months)	n	Drop out	Mortality	Response	Response rate (%)
1	153	7	1	145	94.8
3	152	13	3	136	89.5
6	149	17	1	131	87.9
12	148	21	5	122	82.4
18	143	24	7	112	78.3
24	136	28	5	103	75.7

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Table 2 Differences in characteristics and depressive symptoms between the intervention group and control group (n = 153)

Variable	Experimental group (n = 76, 100%)	Control group (n = 77, 100%)	P-value
Sex, n (%)			0.574†
Female	52 (68.4)	53 (68.8)	
Mean age, years (SD)	77.53 (8.16)	78.49 (7.19)	0.438‡
Education, n (%)			0.286†
Illiterate	40 (52.6)	36 (46.8)	
Elementary education and above	36 (47.4)	41 (53.2)	
Type of surgery, n (%)			0.099†
Internal fixation	53 (69.7)	45 (58.4)	
Arthroplasty	23 (30.3)	32 (41.6)	
Comorbidities at admission, mean (SD)	1.84 (1.40)	1.23 (1.13)	0.004‡
Pre-fracture functional status, mean (SD)§	96.12 (6.41)	96.10 (6.52)	0.989‡
Cognitive status before surgery, mean (SD)¶	23.16 (5.24)	23.99 (5.72)	0.353‡
Drop out, n (%)	12 (15.8)	16 (20.8)	0.278†
Mortality, n (%)	9 (11.8)	13 (16.9)	0.256†
Depression status, mean (SD)††			
Before discharge	5.03 (3.38)	5.99 (3.51)	0.092‡
Month 1	4.41 (3.35)	5.40 (3.94)	0.116‡
Month 3	3.58 (2.99)	5.05 (3.82)	0.017‡
Month 6	3.11 (3.09)	4.42 (4.06)	0.044‡
Month 12	3.22 (3.26)	4.60 (4.27)	0.052‡
Month 18	2.66 (2.72)	3.86 (3.87)	0.084‡
Month 24	2.74 (3.34)	3.90 (3.60)	0.105‡

†χ^2. ‡Independent sample t-test. §Measured by the Chinese Barthel Index. ¶Measured by the Chinese Mini-Mental State Examination. ††Measured by the Chinese version of the Geriatric Depression Scale-short form.

to the hospital for an accidental single-side hip fracture; (iii) receiving hip arthroplasty or internal fixation; (iv) able to carry out a full range of motions against gravity, and some or full resistance, with a pre-fracture Chinese Barthel Index (CBI) score >70; and (v) living in northern Taiwan. Patients were excluded if they were: (i) severely cognitively impaired and completely unable to follow orders (determined by a score <10 on the Chinese Mini-Mental State Examination [MMSE]);[14] or (ii) terminally ill.

Procedure

The clinical trial was approved by the hospital's institutional review board. Patients were recruited from the emergency room by research assistants. Participants were randomly assigned to either an experimental or control group by flipping a coin before the surgery. Coin flipping was carried out by a neutral third party not involved in delivering the intervention or assessing outcomes. Participants in the control group received routine hospital care, outcome assessment visits and regular social contact from a research nurse. Participants in the experimental group received routine hospital care, the intervention program and outcome assessment visits. The participants were blinded to the intervention. Outcomes variables were assessed before discharge, and at 1, 3, 6, 12, 18 and 24 months after discharge.

Intervention program

The intervention program included geriatric consultation services, a continuous rehabilitation program and discharge-planning services.[13] The geriatric consultation was based on geriatric assessments, and delivered before and after surgery by a geriatrician and geriatric nurses to detect potential medical, functional and psychiatric problems, and to decrease delays before surgery.

Continuous rehabilitation was delivered by geriatric nurses and physical therapists to facilitate early postoperative mobility, and to provide rehabilitation in the patient's home setting. Both a hip fracture-oriented intervention and a physical fitness enhancing intervention were included in both the in-hospital and at-home settings for the rehabilitation program. In particular, the rehabilitation protocol emphasized ankle dorsiflexion with knee extension, isometric full knee extension,

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gently bouncing vertical jump with knee semiflexed and foot on the floor, and ball-rolling activities to enhance proprioception. This rehabilitation program was individualized according to each patient's recovery condition.

The discharge planning component was delivered by geriatric nurses to assure continuity of care. Caregiver's competence, resources, family function, patient's self-care ability and needs for community or long-term care services were assessed before discharge, and necessary referrals were made accordingly. The patient's adherence to follow ups in clinics was also monitored by the geriatric nurse.

During the hospital stay, each participant in the intervention program was seen once by a geriatrician and a rehabilitation physician, twice by a physical therapist, and six times by a geriatric nurse. During the 3 months after discharge, each participant received eight visits from a geriatric nurse and three visits from a physical therapist at home.

Usual care

After the surgery, a nurse would teach the patient how to exercise in bed and change their position. Physical therapy usually started the third day after surgery, and the patient was usually discharged from the hospital approximately 5–7 days after surgery. Before hospital discharge, the patient's primary nurse provided discharge health education. However, in-home rehabilitation or nursing care was not provided. The patient was clinically followed at 1, 3 and 6 months after hospitalization, although compliance was often low.

Outcome variables

Depressive symptoms

Depressive symptoms were measured by the Chinese version of the GDS-s.[15,16] Scores on the GDS-s can range from 0 to 15, with higher scores representing more depressive symptoms.[15] Participants with a score ≥5 can be categorized as at risk for a clinical diagnosis of depression.[16] To maximize the sensitivity of the GDS-s score to the intervention, GDS-s score was treated as a continuous variable in the longitudinal outcome analysis to show the severity of depressive symptoms in the present study. The Cronbach's alphas of GDS-s for this study ranged from 0.78 to 0.87.

Covariate variables

Pre-fracture performance of activities of daily living was measured by the CBI through patient self-report.[17] The CBI assesses dependencies in eating, transferring, grooming, toileting, bathing, walking, climbing stairs, dressing, as well as bowel and bladder control. Responses to each item have two to three categories for scoring, with the total CBI score ranging from 0 (total dependence) to 100 (total independence). Validity and reliability of CBI and its suitability for elderly Taiwanese participants have been substantiated.[17] Cronbach's α for the CBI in the present study ranged from 0.83 to 0.93.

Cognitive functioning was assessed with the Chinese version of the MMSE, which was translated from the English version.[18] The 11-item MMSE assesses participants' orientation, memory, common sense, ability to use language, ability of construction, as well as thinking content, form and processes.[14] The total score can range from 0 to 30, with a higher score indicating better cognitive functioning. Satisfactory interrater agreement and construct validity have been reported.[14,19]

Statistical analysis

The group-based trajectory model was used to identify distinctive groups of individual trajectories within the population.[20–23] This approach includes two components. The first component is a latent class analysis, which was used to derive trajectory parameters through maximum likelihood estimation with the following specifications:

$$Y_{iT}^{*g} = \beta_0{}^{g} + \beta_1{}^{g}\ \mathrm{Time}_{iT} + \varepsilon_{iT}^{*} \quad i = 1, \ldots n \tag{1}$$

Y_{iT}^{*g} is a latent variable representing the underlying status of depressive symptoms of individual i at time T (e.g. 1 month) given the membership in group g. Time refers to the timing of assessment from the baseline. The coefficients $\beta_0{}^{g}$ and $\beta_1{}^{g}$ are associated with the intercept and rate of change in depressive symptoms, respectively. ε_{iT}^{*} is a disturbance term assumed as normally distributed with zero mean and constant variance.

A series of models from two to eight groups was systematically examined and compared; the number of groups was determined by using the Bayesian information criterion in conjunction with theoretical explanations. Within each group, depressive symptoms were analyzed as an intercept only, linear or non-linear, model of time. As an illustration, we present equation 1 as a linear function of time.

In the second component, we examined the linkages between the interdisciplinary intervention and the distinct trajectories of depressive symptoms by evaluating the following specifications:

$$\pi_g(z_i) = e^{z_i\theta_g} \Big/ \Sigma_g e^{z_i\theta_g} \tag{2}$$

where θ_g represents the parameters of a multinomial logistic model that captures the effects of predictors z_i (e.g. intervention group and various covariates) on π_g

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Table 3 Estimated trajectory groups and group-specific growth parameters of depressive status (n = 153)

Variable	Non-depressive	Marginally depressive	Persistently depressive
Growth parameter			
Intercept	2.01*	5.47*	7.91*
Linear slope	–0.13*	–0.42*	–0.02
Quadratic slope		0.01*	
Group proportion	37.8%	30.7%	31.5%
Sigma	2.89*		
Model fit statistics			
BIC (n = 854)	–2059.54		
BIC (n = 153)	–2050.94		
AIC	–2035.79		
Log likelihood	–2025.79		

Level 1 (n = 854), level 2 (n = 153). *P < 0.001. AIC, Akaike information criterion; BIC, Bayesian information criterion.

and the probability of membership in group g.[22] Equations 1 and 2 were estimated by the SAS software package (SAS Institute, Cary, NC), with accompanying Proc Traj.[21]

Results

Participants' characteristics

The average age of the participants was 78.01 years (SD 7.68), with over two-thirds being female and approximately half illiterate. The majority of participants had undergone surgery within 48 h of hip fracture (62.1%), and had received internal fixation of the fracture (64.1%). The average number of chronic diseases before admission was 1.53, with an average pre-fracture CBI score of 96.11, and Chinese MMSE score of 23.57 before surgery, indicating relative independent self-care ability before fracture and mildly cognitively impaired to intact before surgery. Table 2 presents the proportions or means of all background variables and depressive symptoms for the experimental group and control group. As shown in Table 2, those who received the intervention program had a significantly higher number of comorbidities, but fewer depressive symptoms at 3 and 6 months after discharge.

Trajectories of depressive status

Our analyses identified three trajectories of postoperative depressive symptoms (Table 3 and Fig. 1), supporting H_1. The first trajectory, a linear function with a downward linear slope (slope = –0.13, $P < 0.001$) over time, could be characterized as a non-depressive group

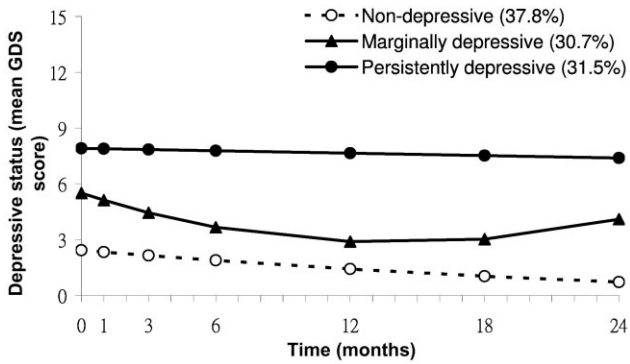

Figure 1 Trajectory groups for depressive status over time. GDS, Geriatric Depression Scale.

(*n* = 58, 37.8%). Participants in this group experienced few depressive symptoms, with mean GDS-s scores from 3 to 0, and their GDS-s scores (depressive symptoms) continued to decrease during the 2 years after surgery (Fig. 1).

The second trajectory, approximated by a quadratic function, had a negative linear slope (b = –0.42, $P < 0.001$), and a positive quadratic slope (b = 0.01, $P < 0.001$) (Table 3). As shown in Figure 1, mean GDS-s scores were initially around 5 to 6, representing borderline risk for depression, and then depressive symptoms decreased substantially from 6 to 3 during the first 12 months after hospitalization. From month 12 to month 24, depressive symptoms substantially increased (to a mean GDS-s score of 5). Thus, the participants in this group can be described as marginally depressive (*n* = 46, 30.7%) with fluctuating symptoms.

Participants in the third trajectory group initially had high GDS-s scores, and were at greater risk for depression (by 8 points on the GDS-s) than participants in the other two groups. This level of GDS-s remained unchanged throughout the 2-year period of follow up. Hence, this trajectory can be characterized as persistently depressive (*n* = 49, 31.5%).

Predictors of trajectories of depressive status

Our interdisciplinary intervention made a significant difference in the depressive symptoms of older Taiwanese hip fracture participants. In particular, relative to those in the control group, participants in the experimental group were significantly less likely to be persistently depressive (b = –1.46, odds ratio [OR] 0.23, $P < 0.05$) over the 2-year period of observation (Table 4). Nevertheless, the interdisciplinary intervention did not significantly reduce the risk of being marginally depressive (b = –1.09, OR 0.34, $P > 0.05$). In terms of the distribution of these three trajectories, 51% of the participants in the intervention group were non-depressive, 22% were marginally depressive and 26%

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Table 4 Factors associated with trajectory group membership

Trajectory group	Covariates	Regression coefficient	Odds ratio (95% CI)
Non-depressive	Reference group		
Marginally depressive	Constant	13.76	
	Experimental group	–1.09	0.34 (1.08–0.11)
	Age (years)	0.02	1.02 (1.11–0.94)
	Sex (male)	–1.63	0.20 (0.70–0.06)*
	Pre-fracture functional status	–0.12	0.89 (1.08–0.73)
	Cognitive status before surgery	–0.10	0.90 (1.03–0.79)
Persistently depressive	Constant	17.78	
	Experimental group	–1.46	0.23 (0.73–0.07)*
	Age (years)	0.04	1.04 (1.12–0.96)
	Sex (male)	–1.33	0.26 (0.85–0.08)*
	Pre-fracture functional status	–0.17	0.84 (1.02–0.70)
	Cognitive status before surgery	–0.13	0.88 (1.00–0.77)*
Model fit statistics			
BIC (n = 854)	–2069.18		
BIC (*n* = 153)	–2051.94		
AIC	–2021.70		
Log likelihood	–2001.70		

Level 1 (n = 854), Level 2 (n = 153). *P < 0.05. AIC, Akaike information criterion; BIC, Bayesian information criterion.

were persistently depressive. In contrast, in the usual care group, 25% were non-depressive, 38% were marginally depressive and 38% were persistently depressive. Hence, our findings support the hypothesized beneficial effect of the interdisciplinary intervention on depressive status, particularly for decreasing the risk for being persistently depressive (H_2).

In view of the fact that there were significant differences in age, sex, pre-fracture functional status and cognitive status before surgery across different depressive group, these variables were included in the analysis as covariates (Table 4). This treatment effect remained significant even with age, sex, pre-facture functional status and cognitive status before surgery controlled.

Relative to those non-depressive, those persistently depressive were more likely to be female, older, in control group, poorly pre-fracture functional status and have poorer cognitive status before surgery. They did not differ significantly in terms of education, type of surgery, comorbidities at admission, loss to follow up and mortality.

Discussion

Postoperative depression after hip fracture has been reported by several investigators.[8,24] For instance, Lenze *et al.* reported that the onset of major depressive disorder is common after hip fracture, and the greatest period of risk is immediately after the fracture.[8] In another study of elderly hip fracture participants in Taiwan, nearly 60% had significant depressive symptoms before discharge, and more than one-third remained so 12 months after discharge, although depressive symptoms declined significantly during the first 6 months after discharge.[24] Both studies were observational, and did not examine the heterogeneity in the course of change in depressive symptoms. To the best of our knowledge, the present study is the first to show distinct trajectories of depressive symptoms among elderly participants after hip fracture within the context of a randomized controlled trial.

Our research showed that depressive symptoms after hip fracture follow three distinct courses: persistently depressive, marginally depressive and non-depressive. These courses differed significantly in terms of their levels of and rates of change in depressive symptoms throughout the 2-year study period. Whereas those in the non-depressive and marginally depressive trajectory groups experienced significant reductions in symptoms over time, those persistently depressive remained unabated. These results are consistent with prior observations of multiple trajectories of depressive symptoms among community-residing older adults in the USA.[10,12] In particular, a sizeable proportion of the participants (31.5%) were persistently depressive, and another 31% were marginally depressive. These two groups certainly deserve the attention of clinicians and caregivers in rendering treatment, management, and care.

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By showing the distinct trajectories of change, our research provides new information on the natural history of depressive symptoms after hip fracture by quantifying their levels and rates of change over a period of 2 years. These trajectories are more informative than measures of depression or depressive risk at one or two time-points, because a significant health difference at one time might diminish or even reverse at a later time. Furthermore, distinct trajectories could reflect differences in etiology, and thus call for targeted treatments. Hence, understanding distinct trajectories in depressive symptoms might facilitate improvements in managing participants after hip fracture.

The present study offers evidence that an interdisciplinary intervention, consisting of geriatric consultation, rehabilitation and discharge planning, yields significant benefits by decreasing the odds for being persistently depressive. However, the interdisciplinary intervention did reduce the odds for being marginally depressive.

Our interdisciplinary intervention might have reduced depressive symptoms because of its continuous rehabilitation program with both hip fracture-oriented and physical fitness components. Although exercise has not been reported to reduce persistent depressive symptoms after hip fracture, exercise has been found in some studies to alleviate depressive symptoms. For example, a meta-analysis of 35 studies comparing exercise interventions with no exercise concluded that exercise had a moderate effect in reducing depressive symptoms after the intervention.[25] Furthermore, an exercise program improved depressive symptoms of elderly Korean women,[26] and continuous exercise was associated with significant therapeutic benefit 6 months after a 4-month exercise program for participants with major depressive disorder.[27] Also, interdisciplinary interventions including exercise components have been found to be effective in decreasing depressive symptoms.[28]

Together, these findings offer support for our hypotheses on three distinct depressive symptom trajectories, particularly the differences between participants who were persistently depressive and those marginally depressive. The trajectories for severity of depressive symptoms show that elderly participants undergoing hip fracture surgery should be assessed several times for depression over an extended period. Knowledge of these trajectories can be used to design primary, secondary and tertiary interventions, and to ascertain their relative effectiveness and efficiency. For example, the interdisciplinary intervention described in the present study can be delivered to participants with hip fracture to decrease their postoperative risk of severe depressive symptoms. In addition, groups at high risk for persistent or marginal depressive symptoms, including female participants with poor cognitive function before surgery, can be identified early and treated with an intervention.

Despite its contributions, the present study had several limitations. First, all participants came from one medical center, limiting generalizability of the findings. Thus, replications across different sites in Taiwan and other nations are required to extend the generalizability. Second, participants for this research were limited to those with CBI scores >70, without severe cognitive impairment, and living at home. Thus, the present findings might not be applicable to patients with poor baseline physical and mental characteristics, and living in a nursing home.

In conclusion, we found that changes in depressive symptoms after hip fracture followed three distinct courses: non-depressive, marginally depressive and persistently depressive. Relative to usual care, the interdisciplinary intervention significantly reduced the likelihood of being persistently depressive. Hence, there is some evidence that the 3-month interdisciplinary intervention was effective in reducing the risk for being persistently depressive over a period of 2 years after hip fracture.

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Disclosure statement

No potential conflicts of interest were disclosed.

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