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Original Article

The Effectiveness of an Outpatient Personalized Multidisciplinary Intervention Model, Guided by Comprehensive Geriatric Assessment, for Pre-Frail and Frail Elderly

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SUMMARY

Background: Our study evaluates the efficacy of an outpatient personalized multidisciplinary intervention model guided by comprehensive geriatric assessment (CGA), for pre-frail and frail elderly.
Methods: A single-arm self-controlled study was conducted at the outpatient departments (OPD) of a medical center in Taiwan. Subjects received personalized multidisciplinary intervention, including physical therapy, psychotherapy, a nutritional consultation, precise medicine, and social resource linkage, as determined by the results of their CGAs. After 3 months of interventions, change in the proportions of the frail status (frail, pre-frail and robust), functional scores, depressive status, cognition, nutritional status, percentage of inappropriate medication used and social resource usage were analyzed. A logistic regression model was applied to determine the predictive factors associated with an improvement in frail severity.
Results: A significant improvement in frail status was found (proportion of frail: 44.5% versus 23.1%, $p < 0.001$). Physical function, depressive and nutritional status were also significantly improved. 18.5% of participants used inappropriate medications, with benzodiazepine hypnotics the most common (40.9%). 24.2% of subjects were successfully linked to social resources. The presence of the frail phenotypes exhaustion was significantly associated with an improvement in frail severity (odds ratio (OR) = 2.77, 95% confidence interval (CI) = 1.15–6.66, p = 0.023). There was a significant dose response relationship between the improvement of frail status and physical training times (proportion of improved frail status: 23.7%, 40.5% and 47.9% for 0, 1–3, and 4–6 times of physical training, $p = 0.03$).
Conclusion: The reported CGA-based, personalized multidisciplinary intervention model was effective at improving frail severity among pre-frail and frail elderly in OPDs.

1. Introduction

Frailty is often described as a sign of functional decline, especially in the elderly, and is a mid-phase between health and morbidity.[1] Several adverse events are associated with frailty, such as falls, fracture, depression, hospitalization, and mortality.[2,3] Taiwan has been an aged society since 2018.[4] The Healthy Aging Longitudinal Study in Taiwan revealed that the prevalence rate of frailty and pre-frailty in Taiwanese people aged 65 years and older was 5.4% and 41.5%, respectively.[5] Frailty is currently an emerging issue in Taiwanese society.

Several interventions have been found to be effective for reducing frailty. Exercise training can improve gait speed, balance, muscle strength, and performance in activities of daily living (ADLs).[6,7] Nutrition quantity and quality are both associated with frailty.[8] Multi-domain interventions that combined nutritional, physical and cognitive training may even reverse frailty among community-living older persons.[9]

Comprehensive geriatric assessment (CGA) conveys information on an individual's biological, functional, psychological, clinical and social conditions, and has been suggested as a good tool for identifying the multidimensional frail status and ensuring appropriate intervention in frail older adults.[10] Several randomized controlled trials found that a tailored multi-disciplinary or CGA-based intervention could decrease the severity of the frailty score and could improve disability.[11,12] Another randomized controlled trial showed that CGA-based interventions in outpatient settings may contribute to improvements in frailty.[13]

In Taiwan, Hsieh et al. investigated personalized home-based exercise, nutrition, and combined 3-months interventions for the improvement of frailty in 319 pre-frail or frail people.[14] Another study conducted a 12-month, community-based, multi-domain intervention for a total of 54 randomized clusters (1,522 participants).[15] Both studies showed decreased frailty and an improvement in functional parameters after the interventions.

Since 2019, the Taiwan Health Promotion Administration (THPA) has actively promoted hospitals to establish a standardized screening, evaluation and intervention protocol for potentially frail elderly individuals in outpatient department (OPD) settings. In response to the THPA's advice, we designed a personalized, multidisciplinary in-

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tervention model based on the results of CGA screening at outpatient clinics at Changhua Christian Hospital (CCH), a medical center in central Taiwan. The model was composed of physical therapy, psychotherapy, nutritional therapy, medication integration and education, case manager intervention, and referral to community resources. The aim of the present study was to determine the efficacy of this model for frail or pre-frail elderly individuals, at a single medical center in Taiwan.

2. Materials and methods

2.1. Study design

This is a single arm, self-controlled study, designed to evaluate the efficacy of a CGA-based, personalized multidisciplinary intervention model applied to pre-frail and frail elderly individuals (aged > 65 years) at CCH OPDs. The study was approved by CCH institutional review board (CCH IRB No. 191105) and all participants signed informed consent. Eligible participants were recruited by physicians or case managers. Participants received the intervention for a total of 3 months. Frailty and other parameters were assessed at baseline and 3 months.

2.2. Participants

We recruited potential participants from individuals who visited internal medicine, neurology, rehabilitation medicine, geriatric medicine, and integrated care OPDs at CCH from December 2019 to December 2020. The inclusion criteria were subjects aged > 65 years with a clinical frailty scale score of 3 to 5, and an independent ADL (Barthel index score 100).[16] Subjects who could not attend the intervention program or refused to give their informed consent were excluded. Fried's frailty phenotype was used to determine the severity of frailty.[17] It defines 5 categories of frailty, including weight loss (unintended body weight loss of > 3 kg or 5% in the past 12 months), weakness (handgrip strength male < 26 kg or female < 18 kg), exhaustion (> 3 days in the past week, subject felt everything he or she did was an effort), slowness (6 m walking speed < 0.8 meter/second) and low physical activity (calories burned per week male < 383 kcal or female < 270 kcal, as confirmed by the International Physical Activity Questionnaire (IPAQ) short form-Taiwan version).[18] Individuals without any abnormalities were defined as robust. Those with 1 or 2 phenotypes were defined as pre-frail, and those with 3 or more were defined as frail.

2.3. Intervention

Participants underwent CGA, which evaluated function (ADL and instrumental ADL (IADL)), frailty (Fried's frailty phenotype), depression (5-item Geriatric Depression Scale, GDS-5),[19] cognition (short portable mental state questionnaire, SPMSQ),[20] nutrition (Short Form Mini Nutritional Assessment, MNA-SF)[21] and medication. We held a multidisciplinary conference once the evaluation was completed to design personalized care plans. The participant was referred to a physical therapist (PT), a psychologist, a nutritionist, and a pharmacist for the corresponding interventions, according to the results of their CGA (Figure 1). All participants were provided with long term care (LTC) resources and followed up by nursing case managers.

2.3.1. Personalized physical therapy

Participants with the abnormalities of weakness, slowness and low physical activity, were referred to a rehabilitation physician and PT. Physical interventions included cardiorespiratory capacity, dynamic standing balancing and muscle strength. Exercise programs contained 3–6 repetitions of 50 minutes machine training and a

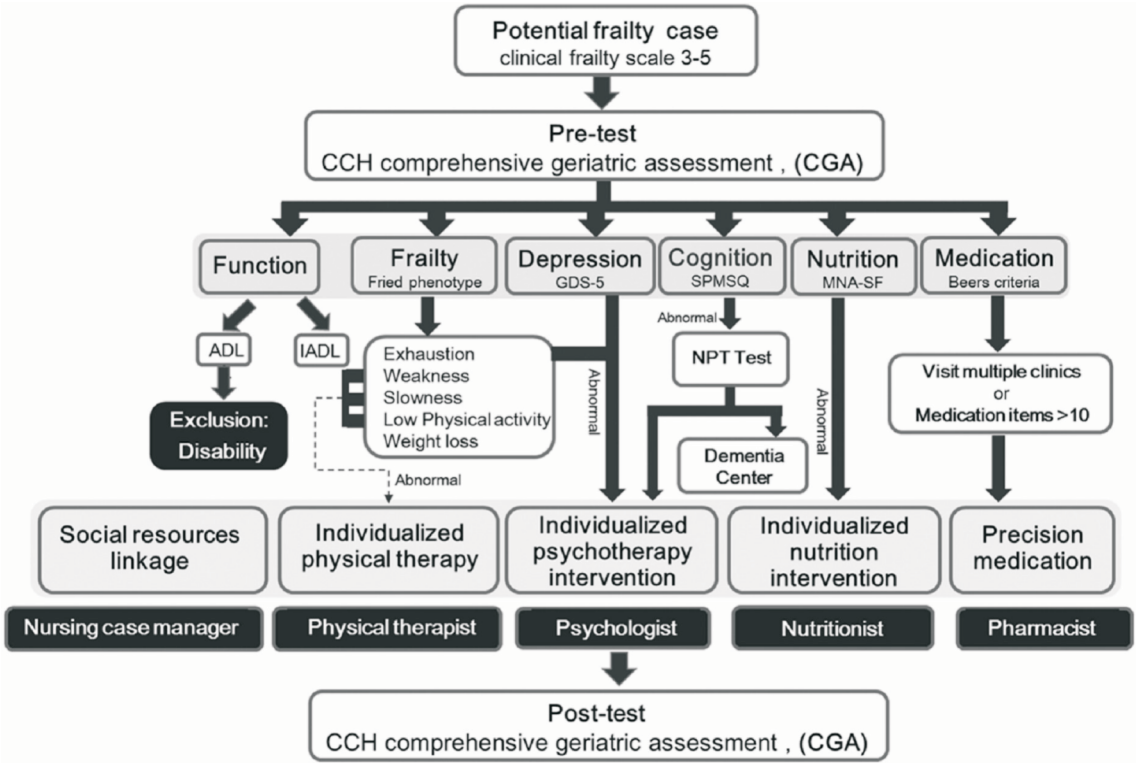

Figure 1. Flow chart of the CGA-based, personalized multidisciplinary intervention model. ADL, activities of daily living; GDS-5, 5-items of geriatric depression scale; IADL, instrumental activities of daily living; LTC, long term care; MNA-SF, Short Form Mini Nutritional Assessment; NPT, neuropsychological test; PT, physical therapist; SPMSQ, short portable mental state questionnaire.

home exercise introduction 1 to 3 times by the PT. Subjects received monthly follow ups by case managers. Details of personalized physical therapy intervention were described in Appendix 1.

2.3.2. Personalized psychotherapy intervention

People who scored > 2 points in the GDS-5 then completed the 15-item Geriatric Depression Scale (GDS-15)[22] and were referred to a psychiatrist for a proper diagnosis and treatments. For participants who reported exhaustion, psychotherapy intervention was introduced. The participants with abnormal results in the SPMSQ (wrong answers ≥ 3) would visit a neurologist and receive neuropsychological testing. Personalized psychotherapy was conducted by a psychologist. The treatment course lasted 30 minutes each time and was arranged 1 to 3 times. Details of psychotherapy intervention were described in Appendix 1.

2.3.3. Personalized nutrition intervention

Participants with an abnormality in the weight loss category according to Fried's frailty phenotype or who scored < 11 points in the MNA-SF were referred to a nutritionist. A complete nutrition evaluation and personalized suggestions were provided. The intervention consisted of one 40-minute nutrition evaluation and active follow-ups. Case managers would report back to the nutritionist for nutrition plan adjustments if needed.

2.3.4. Precise medication

We screened using Beer's criteria for participants with multiple comorbidities (visiting two or more outpatient clinics) or taking medications in > 10 categories.[23] The clinical pharmacist provided medication education to participants and made a personalized medication integration suggestion to their physicians. The intervention included one assessment lasting 30 minutes.

2.3.5. Social linkage to LTC resources

Nursing case managers introduced the LTC 2.0 service and the community comprehensive care system to every participant.[24] Subjects were encouraged to utilize community resources to join healthy activities and avoid social isolation. Participants with a suspected or confirmed dementia were transferred to a dementia center. The dementia collaborative team liaised with both the patient and their caregivers to make a person-centered care plan.[25] Case managers arranged tailored interventions, provided health education, and continued follow up monthly for 4 months at least.

2.4. Outcome evaluation

Outcome assessment was performed at baseline and 3 months. Participants were followed monthly by case managers for 4 months. The primary outcome was the change in the proportions of the frail status before and after the intervention. Secondary outcomes included functional evaluation (ADL by Barthel index and IADL by Lawton IADL Scale),[26] depressive status (GDS-5 and GDS-15), cognition (SPMSQ), nutritional status (MNA-SF), percentage of inappropriate medication used, and percentage of social resources used.

2.5. Statistical analysis

All data were analyzed using R software. A paired t-test was used to compare the mean difference among groups, while a Chi-squared test was used for nominal variables. The odds ratios (OR) and 95% confidence intervals (CI) were estimated using a logistic regression model. A p-value < 0.05 was considered to indicate a statistically significant difference.

3. Results

A total of 206 individuals were eligible for inclusion within this study. However, 24 of them refused any interventions due to the COVID-19 pandemic. 182 individuals were allocated to different interventions according to our personalized model. The mean age of the 182 participants was 76.1 ± 6.9 years. 104 (57.1%) of the participants were female; 81 (44.5%), 98 (53.8%), and 3 (1.7%) of the participants were in frail, pre-frail, and robust condition. The participant's characteristics are listed in Table 1. Baseline characteristics of 24 excluded subjects were similar to included participants except higher percentage of dementia (Supplementary Table 1).

In our study, 174 (95.6%) individuals met the criteria for personalized physical therapy and 137 (75.3%) of them received the intervention. 37 participants were only provided with home exercise instructions (8 participants rejected machine training and 29 refused to return to the hospital because of the COVID-19 pandemic) without a machine training program. 25 (17.6%), 63 (34.6%), and 65 (35.7%) individuals fit the criteria for psychotherapy, nutrition intervention and precise medication, respectively. Twelve participants (18.5%) used inappropriate medications as listed on Beer's criteria. Among them, the most common inappropriate medications used were benzodiazepine hypnotics (40.9%), followed by glimepiride (13.6%). 44 participants (24.2%) utilized LTC resources during the intervention period. Community elderly stations and community dementia care centers accounted for the majority. Detailed data were listed in Appendix 2.

Table 2 shows the outcomes of the personalized interdisciplinary intervention model. Post-tests were arranged an average of 94.5 days after the baseline tests. Frail severity, as measured by the change of the proportions of frail status, improved significantly after the interventions ($p < 0.001$). In the physical function domain, there was an improvement in grip strength of both genders (male: 24.7 versus 26.4 kg, $p < 0.001$; female: 16 versus 17 kg, $p < 0.001$), walking speed (6 meter walking time: 10.4 versus 8.8 seconds, $p < 0.001$) and exercise calories burned per week (male: 1077.6 versus 1237.2 kcal,

Table 1
Basic characteristics of the study participants (n = 182).

Characteristic	Value
Age (years), mean (standard deviation)	76.1 (6.9)
Female sex, n (%)	104 (57.1%)
Male sex, n (%)	78 (42.9%)
Time interval between pretest and posttest (day), mean (standard deviation)	94.5 (77.7)
Medical problems	
Dementia, n (%)	83 (45.6%)
Cerebrovascular disease, n (%)	34 (18.7%)
Parkinson's disease, n (%)	20 (11.0%)
Hypertension, n (%)	83 (45.6%)
Diabetes mellitus, n (%)	50 (27.5%)
Hyperlipidemia, n (%)	71 (39.0%)
Cardiovascular disease, n (%)	26 (14.3%)
Chronic kidney disease, n (%)	14 (7.7%)
Frailty status	
Frail, n (%)	81 (44.5%)
Prefrail, n (%)	98 (53.8%)
Robust, n (%)	3 (1.7%)
Referral department	
Neurology, n (%)	177 (97.3%)
Physical medicine and rehabilitation, n (%)	3 (1.6%)
Nephrology, n (%)	2 (1.1%)

Table 2
Outcomes of multi-disciplinary personalized interventions.

Categories	Participants	Pretest	Posttest	Difference	p-value
Frail status	182			-	< 0.001
Frail		81 (44.5%)	42 (23.1%)		
Pre-frail		98 (53.8%)	102 (56%)		
Robust		3 (1.7%)	38 (20.9%)		
ADL (Barthel index score), points	182	100 ± 0	99.6 ± 3.4	-0.4	0.159
IADL (Lawton IADL Scales), points	182	18.1 ± 6.3	17.8 ± 6.4	-0.3	0.115
Grip strength, kg					
Male	78	24.7 ± 5.7	26.4 ± 6.3	1.7	< 0.001
Female	104	16 ± 4.4	17 ± 4.7	1.0	< 0.001
Slowness (6-meters walking time), seconds	182	10.4 ± 4	8.8 ± 3.9	-1.6	< 0.001
Exercise calories burned per week, kcal					
Male	78	1077.6 ± 2282.7	1237.2 ± 2412.4	159.6	0.057
Female	104	617.1 ± 705.5	704 ± 695.7	86.9	0.014
SPMSQ, points	182	8 ± 2.7	8 ± 2.6	0	0.9
GDS-5, points	182	0.8 ± 1	0.5 ± 0.9	-0.3	< 0.001
GDS-15, points	31	6.9 ± 2.7	4.9 ± 3.4	-2	0.005
MNA-SF, points	182	12 ± 2.1	12.5 ± 1.7	0.5	< 0.001

p = 0.057; female: 617.1 versus 704 kcal, p = 0.013). There were significant improvements in the participants' depressive scores (GDS-5: 0.8 versus 0.5, p < 0.001; GDS-15: 6.9 versus 4.9, p = 0.005) and nutritional assessment scores (MNA-SF: 12 versus 12.5, p < 0.001). However, no significant changes were observed for the participants' cognitive function (SPMSQ score).

To demonstrate the dose response relationship, individuals met criteria of physical therapy (n = 174) were categorized into 3 groups based on the frequency of machine training (0, 1–3, and 4–6 times). Significant improvements in frail status (proportion of subjects with improved frail status: 23.7%, 40.5% and 47.9%, p = 0.03), grip strength (0.08, 0.33 and 2.39 kg, p < 0.001) and gait speed (-0.32, -0.64, and -2.73 seconds, p < 0.001) were observed among the three groups. Detailed data was listed in Supplementary Table 2.

Supplementary Table 3 shows the characteristics of participants who had improved frail status (frail to prefrail, prefrail to robust, or frail to robust) after the intervention. Individuals who presented with the frail phenotype of exhaustion, had a significantly higher tendency to improve their frail severity. The improved frail severity group also had a higher percentage of participants who received physical therapy.

Table 3 reports the multivariate logistic regression model for possible predictive factors associated with improvements in frail status. The presence of the frail phenotypes exhaustion (OR = 2.77, 95% CI = 1.15–6.66, p = 0.023) was significantly associated with a decrease in frail severity. The presence of body weight loss (OR = 2.55, 95% CI = 0.99–6.58, p = 0.053) and acceptance of physical therapy intervention (OR = 2.76, 95% CI = 0.97–7.85, p = 0.056) also had a trend to improve frailty.

Table 3
Multivariate logistic regression model for predicting factors associated with improvements in frail status after intervention.

Variable	OR	95% CI	p-value
Age (Reference: 60–70)			
70–80	0.56	[0.24;1.32]	0.185
80–90	0.68	[0.24;1.93]	0.470
90–100	0.00	[0.00;Inf]	0.988
Male	1.25	[0.62;2.49]	0.531
Diagnosis			
Dementia	0.99	[0.47;2.07]	0.971
CVD	0.51	[0.19;1.33]	0.169
Hypertension	1.39	[0.61;3.15]	0.428
Hyperlipidemia	2.28	[0.99;5.26]	0.053
DM	0.55	[0.23;1.33]	0.184
CAD	0.61	[0.21;1.75]	0.359
CKD	1.27	[0.32;5.00]	0.729
Malignancy	2.90	[0.86;9.77]	0.085
Presence of frailty phenotype			
Weight loss	2.55	[0.99;6.58]	0.053
Exhaustion	2.77	[1.15;6.66]	0.023
Reduced grip strength	0.56	[0.26;1.23]	0.150
Reduced walking speed	1.21	[0.45;3.30]	0.703
Low physical activity	0.90	[0.44;1.82]	0.767
Intervention			
Physical therapy	2.76	[0.97;7.85]	0.056
Psychotherapy	0.49	[0.13;1.89]	0.303
Nutrition intervention	0.59	[0.24;1.47]	0.256
Precision medication	0.97	[0.42;2.22]	0.933

CAD: coronary artery disease; CI: confidence interval; CKD: chronic kidney disease; CVD: cerebrovascular disease; DM, diabetes mellitus; OR: odds ratio.

4. Discussion

The present study revealed that a CGA-based, personalized multidisciplinary intervention model in an outpatient clinical setting, was effective at reducing frail severity, improving physical and nutrition status, and ameliorating depressive moods in frail and pre-frail individuals. Participants who had the frail phenotypes of body weight loss or exhaustion and who received personalized physical therapy, were more likely to have an improved frail severity after the interventions. Our model integrated the frail phenotype and CGA to make targeted intervention guidelines for non-disabled frail and pre-frail elderly individuals in an OPD setting.

Several studies have found synergic effects when applying multi-domain interventions.[11–13] However, the combination of different interventions means more resource expenditure. Our study evaluates the use of Fried's frail phenotypes and CGA in combination to target interventions, which may be a more cost-effective evaluation method.

Despite different designs, a multi-component exercise program, which includes aerobic, resistance, and balance exercise, is considered to be the best strategy for improving frailty hallmarks.[27,28] Our personalized training program also consisted of the three components. After a three-month training course, handgrip strength, walking speed, and daily physical activity showed significant improvement.

Our CGA-based intervention also showed improvement in the

patient's depressive moods and nutrition status. Some studies found that combined intervention models could reduce depressive symptoms.[9,15] However, similar effects were not observed in another study.[11] Psychotherapy has been suggested for treating mild to moderate depression. Incorporating psychotherapy into a multi-domain intervention could be beneficial for frail elderly individuals with depressive symptoms.

The present study did not reveal a significant change in cognitive function after the interventions. A possible explanation is that 45.6% of participants had neurologist confirmed dementia. The effects of multi-domain interventions for frail elderly on cognitive outcomes have previously been inconsistent.[29] Most positive studies excluded subjects with clinically diagnosed dementia.[15,30] Only 16 subjects (8.8%) in the present study received a cognitive training course at the community dementia care centers. The high percentage of dementia subjects and the lack of routine cognitive training performed in the present model, could explain the lack of improvement the model had on cognitive function.

A previous systemic review concluded that physical exercise plays an essential role in multi-domain interventions.[29] The present study revealed that personalized physical therapy has trend to improve the frail status after multidisciplinary intervention. In addition, there were significant dose response relationship between improvement of frail status and physical training times. The present study result was consistent with previous findings.

People who had the frailty phenotype of exhaustion, are more prone to having a decrease in their frail severity. To the best of our knowledge, there have been no previous studies evaluating frail phenotypes and their association with the efficacy of interventions. Although in different disease entities, clinical presentations of chronic fatigue syndrome and fatigue category in Fried's frailty phenotype shares some similarities. A literature review concluded that graded exercise therapy and cognitive behavioral therapy are both effective in treating chronic fatigue syndrome.[31] Both interventions were included in the present multidisciplinary model, which might be able to explain the relationship. More researches are needed to declare the effect of frail phenotypes on the efficacy of interventions.

The present study reports an effective model for OPD settings. Most previous studies have delivered the interventions at home,[11,14,32] or in the community.[15] Because of the high accessibility to health care in Taiwan, targeted personalized intervention in OPD settings could be a suitable and cost-effective solution for non-disabled subjects with a mild clinical frailty score. The present study had several limitations. First, the design was a single arm, self-controlled study without a control group, which could have affected the interpretation of the study results. Second, around 20% of participants declined to travel to an intervention, even though they met our intervention criteria, because of the COVID-19 pandemic. Instead, case managers telephoned them or visited them directly at the OPD to give intervention instructions. Third, the present study focused on 3-month outcomes. More long-term follow-up and analysis are warranted.

In conclusion, our CGA-based, personalized multidisciplinary intervention model in OPD settings is effective for the improvement of frailty and pre-frailty. A combination of frail phenotypes and CGA efficiently formed a targeted multi-dimensional intervention. The model focused on personalized physical therapy, psychotherapy, nutrition intervention, precise medication usage and linkage with a social network. Improvements in frail severity, physical performance, depression, and nutrition status were observed, especially in participants who received physical therapy intervention or who had the frailty phenotypes of body weight loss or exhaustion.

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Declaration of any potential financial and non-financial conflicts of interest

None.

Supplementary materials

Supplementary materials for this article can be found at http://www.sgecm.org.tw/ijge/journal/view.asp?id=21.

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