ORIGINAL RESEARCH

Cognitive stimulation during hospitalization improves global cognition of older Taiwanese undergoing elective total knee and hip replacement surgery

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Abstract

Aim. This article is a report on a pilot study conducted to determine the effects of cognitively stimulating activities in older patients undergoing elective hip and/or knee replacement.

Background. Cognitive decline occurs in 16–35·5% of older hospitalized patients. In-hospital interventions, such as cognitively stimulating activities, might combat cognitive decline. However, evidence supporting such interventions is limited.

Methods. For this randomized pilot trial, 50 older patients (90% women with a mean age of 72·8 years) were recruited in 2008 from a tertiary medical centre in Taiwan. While hospitalized, participants in the intervention group received a daily nurse-led, individual-based, cognitive-stimulation intervention. The comparison group received usual care. Cognitive function was assessed using Mini-Mental State Examination at admission, discharge and 1 month after discharge.

Results. The incidence of cognitive decline (≥2-point decline in cognitive score) by hospital discharge was significantly lower for the intervention group (12%) than the usual care group (44%). The intervention group also had better cognitive scores following hospitalization. Upon discharge, participants in the intervention group scored 1·28 points higher than at admission, whereas participants in the usual care declined by 0·76 points. Improvement in cognitive status persisted for the intervention group (+1·33 points) vs. usual care (−0·26 points) at 1 month after discharge. Group differences in changes were statistically significant both at discharge and 1 month afterwards.

Conclusion. Our cognitive-stimulation intervention benefited global cognitive function among older patients undergoing elective hip and/or knee replacement. The benefit persisted at 1 month after discharge.

Keywords: cognitive decline, cognitive impairment, cognitive intervention, cognitive stimulation, nursing, older people, randomized controlled trial

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Introduction

Cognitive function often declines in adults who are more than 65 years old, after a cascade of events initiated by acute illness and hospitalization (Ehlenbach *et al.* 2010). For example, the cognitive function of up to one-third of older hospitalized patients in the United States of America has been shown to decrease significantly by discharge. When measured using the Mini-Mental State Examination (MMSE), cognitive status scores decreased by more than 1 point in 25·9–35·5% of patients (Huber & Kennard 1991) and by more than 2 points in 16–23% of patients (Fitzpatrick *et al.* 2004). In fact, prevalence of cognitive decline accompanying hospitalization is as high as 50–60% (Price *et al.* 2008, Chen *et al.* 2010), particularly for older patients undergoing major surgery and anaesthesia (Monk *et al.* 2008). Among older hospitalized patients in Taiwan, such cognitive decline did not recover and might decline further for some patients (Chen *et al.* 2011). Thus, preventing cognitive decline commonly seen in older postoperative patients is important, because cognitive decline often leads to frailty and increased mortality and health cost (Pedone *et al.* 2005, Lavery *et al.* 2009).

On a positive note, the brains of older people have been suggested to be capable of responding to environmental demands by creating new functional synapses, neurons and networks (Burke *et al.* 2007). These findings raise the possibility of successfully intervening to prevent cognitive decline and promote cognitive functioning. Thus, cognitive decline following hospitalization could theoretically be prevented or minimized by in-hospital interventions with cognitively stimulating activities such as daily visits, reality orientation, orientating communication, crossword puzzles, reminiscence and enriched environment. However, clinical evidence to support this possibility is limited.

To fill this gap in knowledge, we designed this randomized controlled pilot trial to test the effects of a daily nurse-led, individual-based, 20- to 30-minute cognitive-stimulation intervention on cognitive functioning in older Taiwanese patients undergoing elective total knee replacement (TKR) and/or total hip replacement (THR).

Review of the literature

Interventions to stimulate cognitive function are based on the view that engaging in a variety of mental activities facilitates 'neural plasticity', thus maximizing cognitive functioning (Breuil *et al.* 1994). 'Cognitive stimulation' is often used to refer to any activity that requires cognitive processing (Vance *et al.* 2008). Sustained engagement in cognitively stimulating activities has been found to impact neural structure in both older human and rodent subjects (Churchill *et al.* 2002, Fratiglioni *et al.* 2004). Furthermore, individuals who remain engaged in activities requiring the use of cognitive abilities may have less risk of cognitive decline and cognitive impairment (Valenzuela & Sachdev 2005, Spector *et al.* 2008). This 'use it or lose it' approach to cognitive decline has stimulated interest in those caring for an increasingly ageing society.

Neural plasticity is linked to the concept of synaptic pruning, i.e. the idea that individual connections in the brain are constantly being removed or recreated, largely depending upon how they are used. This concept is captured in the aphorism, 'neurons that fire together, wire together'. In other words, if two nearby neurons often simultaneously produce an impulse, they may develop neuronal projections to the same cortical area. Furthermore, when neurons are initially exposed to novel stimuli, they begin to grow and establish new connections with other neurons (i.e. synapses), and as experiences are repeated, neural pathways and connections are strengthened, and cognitive reserve is increased (Stern 2002).

Therefore, cognitive stimulation requires explicit engagement in cognitively stimulating activity with the intent to stimulate connections between neurons. *Cognitive stimulation* is one type of approach for managing dementia and cognitive decline. However, other approaches have been reported, e.g. *cognitive training* (i.e. memory training, attention speed training) and *cognitive rehabilitation* (developing individual ways to compensate for cognitive impairment, thus maintaining independence in activities of daily living). These three approaches differ in their treatment goals. Cognitive training focuses on domain-specific cognitive functions (Jobe *et al.* 2001, Ball *et al.* 2002, Willis *et al.* 2006), and cognitive rehabilitation focuses on minimizing dependency due to cognitive impairment (Kurz *et al.* 2009), whereas cognitive stimulation is more generally aimed at engaging individuals in cognitive-stimulating activities of any kind, thus maintaining or maximizing global cognitive function (Clare & Woods 2004).

Therefore, we drew on the literature on individual cognitive-stimulation programmes that appeared to be effective and feasible for acute care settings (Inouye *et al.* 2000,

Spector *et al.* 2008) to develop our individual-based cognitive-stimulation intervention. To that end, our intervention included an active form of orientation to time, place, people and feeling (orientation was embedded in events that interested participants), discussion of current or past events and categorizing objects.

The study

Aim

The aim of this pilot study was to determine the effects of a daily, individual-based, cognitive-stimulation intervention in older hospitalized patients undergoing elective TKR and/or THR surgery.

Design

This study was a prospective, single-blinded, randomized controlled pilot trial.

Participants

Participants were recruited from qualified patients admitted to any of three orthopaedic wards between April and August 2008 at a 2200-bed medical centre in northern Taiwan. Qualified patients had to meet three inclusion criteria: (1) age

of 65 years or older, (2) scheduled for elective TKR and/or THR and (3) able to communicate.

Of 64 eligible patients, 50 (78%) agreed to participate. The reasons given for not participating were 'not interested', 'not feeling well' and 'declined to consent'. Of the 50 participants enrolled, 47 (94%) completed all follow-ups. Reasons for attrition were readmission for other conditions ($n = 1$), and living too far away, so they could not return for 1-month follow-up ($n = 2$). For patient flow, see Figure 1. All patients who consented to participate were randomized into either the intervention or usual care group, according to a computer-generated randomization table.

Intervention and usual care

The intervention consisted of an individual-based, daily cognitive-stimulation programme administered by one nursing staff (CMC). The protocol involved 20–30 minutes of orientating communication and cognitively stimulating activities such as discussing current events, recalling past events, word games or categorizing objects. This cognitive-stimulation intervention was designed to actively engage participants in recalling or discussing issues that interested them. During the intervention, CMC inquired about time-, place- and person-related orientation information (including relationships, feelings and viewpoints), thus reinforcing cognitive activity and orientation. The intervention started after
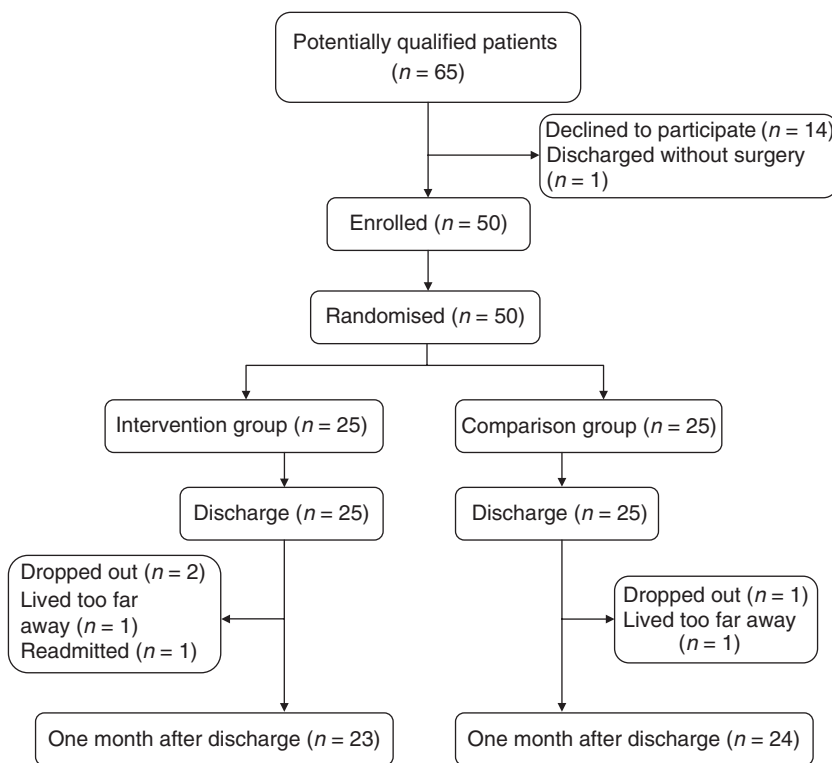

Figure 1 Patient flow chart.

participants returned from surgery to the inpatient orthopaedic wards and ended upon hospital discharge. Most participants in the intervention group received 6 days of cognitive stimulation.

Usual care consisted of standard hospital services provided by physicians, nurses and supportive staff in the orthopaedic wards. The nurse (CMC) did not provide services to patients assigned to usual care. However, the same attending physicians provided care to patients in both the intervention and usual care groups.

Data collection

Data on primary outcomes and associated variables were collected from participants in face-to-face assessments by one nursing staff, blinded to the study aims, using validated instruments, as described below.

Primary outcomes: cognitive decline and cognitive function

The primary outcome, cognitive decline (yes/no), was defined as a decline of 2 or more points in cognitive function (MMSE score) between admission (baseline) and discharge. A decline of at least two MMSE points can be reliably measured (in a 90% confidence level) at intervals up to 1·5 years (Hensel *et al.* 2007). We also compared the between-group difference in cognitive function at three times: admission, before discharge and 1 month after discharge. Cognitive function was assessed using the MMSE, which measures global cognitive function in five domains: memory, attention, language, praxis and visual-spatial ability. The summed scores range from 0 to 30, with higher values denoting better cognitive status (Folstein *et al.* 1975, Shyu & Yip 2001).

Associated variables

Variables associated with cognitive decline included demographics, clinical factors and presence of depressive symptoms. Demographics included age, education level (years), gender, living with others (yes/no) and retired (yes/no). Clinical factors included preoperative comorbidity, type of surgery (unilateral vs. bilateral hip/knee replacement), type of anaesthesia (general, spinal and spinal plus epidural anaesthesia), duration of surgery (minutes), blood loss (mL), amount of blood transfused (unit) and depressive symptoms. Comorbidity was measured using the Charlson Comorbidity Index, a multi-disease-specific weighted summary measure, with possible scores of 0–37 and higher scores indicating greater mortality risk (Charlson *et al.* 1987). Duration of surgery, defined as the time between initial skin incision and skin closure, was assessed by reviewing anaesthesia and operative notes. Depressive symptoms were measured using

the 15-item Geriatric Depression Scale Short-Form (GDS-15), with higher scores indicating more depressive symptomatology (Yesavage *et al.* 1983).

Ethical considerations

The study was approved by the research ethics review committee of the study site. At the beginning of all contacts with patients, a nurse (CMC) explained the purpose and confidential nature of the study, benefits and risks to voluntary participation, and the right to decline to answer all or some questions. Written consent was obtained; consent-by-proxy was not used due to both ethical and methodological concerns.

Data analysis

Data were double-entered to ensure accuracy. Statistical significance was set at $P < 0.05$. Data were analysed using SAS, version 9.2 (SAS Institute Inc., Cary, NC, USA). The data for both groups were first analysed for demographic, clinical characteristics and distribution of cognitive changes. Intervention effects were evaluated, and correlations in repeated measures over time were accounted for by the generalized estimating equation (GEE) approach. For a given outcome, the GEE model included the following predictors: treatment (1 = intervention group, 0 = usual care group), two dummy variables representing measurement times at discharge and 1 month after discharge (1 = measures at discharge or 1 month afterwards, 0 = measurement at admission) and two interaction terms representing time and group interaction.

Results

Participant characteristics

The study sample ($n = 50$) was relatively diverse in age, gender and educational level. Most participants were married and retired, and the majority was living with others. They had a mean age of 72·8 years (SD = 5·7, range = 65–87). Details of the sample demographical and clinical characteristics are presented in Table 1. These characteristics did not differ between the intervention and usual care groups.

Incidence of cognitive decline at discharge

At hospital discharge, 44% of older participants ($n = 11$) in the usual care group experienced cognitive decline (≥2 MMSE-point decline) compared with only 12% ($n = 3$) in the intervention group ($P = 0.012$).

Table 1 Participants' baseline characteristics by group

Characteristic	Intervention (*n* = 25)	Usual care (*n* = 25)	*P*
Demographical			
Age (years), mean (SD)*	73·0 (6·3)	72·6 (5·1)	0·97
Education (years), mean (SD)*	5·3 (4·1)	3·7 (4·4)	0·19
Women, *n* (%)†	21 (84)	24 (96)	0·35
Living with others, *n* (%)†	21 (84)	24 (96)	0·35
Retired, *n* (%)†	23 (92)	21 (84)	0·68
Clinical factors			
Type of surgery, *n* (%)†			
Unilateral total knee replacement†	15 (60)	16 (64)	1·00
Bilateral total knee replacement†	8 (32)	8 (32)	
Unilateral total hip replacement†	2 (8)	1 (4)	
Type of anaesthesia, *n* (%)†			
General anaesthesia	1 (4)	0 (0)	0·61
Spinal anaesthesia	22 (88)	24 (96)	
Spinal & epidural anaesthesia	2 (8)	1 (4)	
Duration of surgery (minutes)*	147·2 (50·0)	146·9 (58·3)	0·76
Blood loss (mL)*	241·7 (113·9)	237·5 (154·1)	0·42
Amount of blood transfused (unit)*	3·4 (2·9)	3·2 (2·3)	0·98
Admission Charlson Comorbidity Index*	0·7 (1·2)	0·5 (0·6)	1·00
Admission depressive symptoms*	2·8 (2·2)	3·8 (3·0)	0·30
Room type, *n* (%)†			
Single	3 (12)	2 (8)	0·20
Double	14 (56)	20 (80)	
Triple	8 (32)	3 (12)	
Number of visitors/day*	1·3 (0·8)	1·7 (1·3)	0·46
Length of hospital stay (days)*	9·5 (2·3)	9·4 (1·4)	0·76

*Based on Wilcoxon rank-sum test.
†Based on chi-squared test.

Cognitive function over time

Cognitive function (MMSE scores) was evaluated over three times for both groups using GEE modelling. Results indicated that the cognitive-stimulation intervention significantly benefited global cognitive function. Table 2 shows the mean changes in MMSE scores between the intervention and usual care groups. Specifically, upon discharge, participants in the intervention group scored 1·28 MMSE points higher than their admission baseline, whereas the MMSE score of participants in the usual care declined by 0·76 points. The mean MMSE score change for the intervention group upon hospital discharge was 2·04 points better than that of the usual care

Table 2 Mean changes in cognitive function by group

Outcome	Intervention (*n* = 25) Mean (SE)	Usual care (*n* = 25) Mean (SE)	Group difference Mean (SE)	*P*
Cognitive function (MMSE score)				
Admission (baseline)	25·36 (0·80)	23·92 (0·89)	1·44	0·23
Change at discharge*	1·28 (0·52)	−0·76 (0·42)	2·04	0·002
Change at 1 month after discharge*	1·33 (0·46)	−0·26 (0·58)	1·59	0·032

Analyses based on GEE modelling.
MMSE, Mini-Mental State Examination; SE, standard error.
*Compared with MMSE score at admission.

group (β = 2·04; *P* = 0·002). One month after discharge, this improvement in cognitive status persisted for the intervention group (+1·33 MMSE points) whereas the MMSE score of the usual care group was still lower than at admission, a decline of 0·26 points. The mean change in MMSE score of the intervention group was 1·59 points better than that of the usual care group (β = 1·59; *P* = 0·03). These results indicate that this cognitive-stimulation intervention effectively improved the cognitive function scores at hospital discharge, and this improvement persisted at 1 month after discharge.

Discussion

Study strengths and limitations

A major strength of this study is that its design was a rigorous randomized controlled trial. However, the study had important limitations. First, the MMSE is a screening tool. Although it is reasonable to use, its outcomes should be followed up by more thorough assessments. Second, the sample in this trial was small and mostly women, limiting generalization of results to other older populations. Generalizability was also affected by attrition of 6·0% (*n* = 3). As outcomes were not imputed, inferences were conditional on retention. However, the GEE approach allows partial information to be used, so that those who drop out can still contribute to estimating outcomes before attrition. While our participants were patients of a single medical centre, the participation rate was 78%, enhancing generalizability.

Intervention effects

The most noteworthy findings of this study are that a daily, individual-based, cognitive-stimulation intervention effectively reduced rates of cognitive decline upon discharge

What is already known about this topic

- Older patients have high rates of cognitive decline during and following major surgery and hospitalization.
- Neurological data suggest that in-hospital interventions such as cognitively stimulating activities would combat cognitive decline, but this possibility is not supported by clinical evidence.

What this paper adds

- A daily 20- to 30-minute, individual-based, cognitive-stimulation intervention reduced the incidence of cognitive decline at discharge (≥2-point decline in Mini-Mental State Examination score from admission) from 44% in the usual care group to only 12% for the intervention group.
- At hospital discharge, participants in the intervention group scored 1·28 points higher on cognitive status than at admission, whereas the scores of participants receiving usual care declined by 0·76 points.
- A daily 20- to 30-minute, individual-based, cognitive-stimulation intervention benefited the global cognitive function of older patients undergoing elective knee and/or hip replacement. The benefit persisted at 1 month after discharge.

Implications for practice and/or policy

- Cognitive assessment should be included as part of older patients' postoperative follow-up to facilitate early identification of cognitive decline.
- This nurse-led, daily, 20- to 30-minute, individual-based, cognitive-stimulation intervention can be successfully implemented in orthopaedic wards to clinically benefit older patients undergoing elective knee and/or hip replacement.

(44% versus 12%) and improved cognitive function (MMSE scores) up to 1 month after hospital discharge. At hospital discharge and 1 month later, older postsurgical patients who received 6 days of our cognitive-stimulation intervention for an average of 23·0 ± 8·6 minutes/day scored 2·04 and 1·59 MMSE points higher, respectively, than their counterparts receiving usual care. The intervention was feasible, but did require ongoing cooperation between physician and nursing leadership to achieve compliance with the protocols.

The high rate of cognitive decline in the usual care group (44%) also highlights the need for timely intervention,

targeting individuals at high risk of cognitive decline. This cognitive-stimulation intervention appears to more actively engage patients than traditional reality orientation, which involves presenting and repeating time, place and person-related orientation materials to patients, e.g. clocks, calendars, maps. Reality orientation, however, was criticized for its passivity, one-way communication and insensitivity to the needs of individuals (Powell-Proctor & Miller 1982). To address these shortcomings, we modified reality orientation in the context of individuals' interests to develop a patient-centred, clinically feasible cognitive-stimulation intervention. The positive outcomes of our intervention indicate that cognitive stimulation prevents postsurgical cognitive decline and improves cognitive function (MMSE scores) up to 1 month following hospital discharge. Questions remain on how such cognitively stimulating activities might structurally and functionally affect the brain. For instance, are the intervention effects due to neurogenesis, more synapses (dendrite growth) or more efficient use of existing networks (synaptic complexity)? Another possible explanation for our results is that they were not due to the cognitive-stimulation intervention, but to the extra attention and social contact that the intervention group received.

Nevertheless, Taiwan and many other countries currently have no mechanism to manage older patients with high risk of cognitive decline during and after major surgery and hospitalization. Our findings support the notion of including cognitively stimulating activities such as active, orienting communication as part of daily nursing care for these older inpatients to prevent their cognitive decline and promote cognitive recovery. With patients being increasingly managed by advanced practice nurses, it is imperative to increase front-line nurses' awareness of potential strategies to prevent cognitive decline following surgery and hospitalization.

Conclusion

Delaying or preventing cognitive decline through effective cognitive-stimulation interventions is a clinical priority (Williams *et al.* 2010), particularly in the absence of a curative treatment for dementia and cognitive decline following surgery and hospitalization. This nurse-led, individual-based, daily 20- to 30-minute cognitive-stimulation intervention effectively maintained cognitive function of older postsurgical patients up to 1 month after discharge. Thus, this intervention not only opens the door to an array of possible new directions in preventing cognitive decline following hospitalization but also holds significant implications for improving outcomes and quality of life for older patients after major surgery. Nurses are in key positions to

detect, intervene and develop new cognitively stimulating strategies for patients at risk of cognitive decline.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

CMC, MJC, YIS and CCHC were responsible for the study conception and design. CMC, JHW, HCL and CCHC performed the data collection. CMC, GHH and CCHC performed the data analysis. CMC, MJC and CCHC were responsible for the drafting of the manuscript. MJC, JHW, HCL, YIS, GHH and CCHC made critical revisions to the paper for important intellectual content. GHH provided statistical expertise. CCHC obtained funding. JUW, HCL and CCHC provided administrative, technical or material support. MJC, YIS and CCHC supervised the study.

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