

HOSTED BY



Contents lists available at ScienceDirect

## International Journal of Nursing Sciences

journal homepage: <http://www.elsevier.com/journals/international-journal-of-nursing-sciences/2352-0132>

## ORIGINAL ARTICLE

# A nursing protocol targeting risk factors for reducing postoperative delirium in patients following coronary artery bypass grafting: Results of a prospective before-after study



Weiyang Zhang<sup>a</sup>, Yan Sun<sup>a</sup>, Yang Liu<sup>a</sup>, Wenjuan Qiu<sup>a</sup>, Xiaofei Ye<sup>b</sup>, Guihong Zhang<sup>a</sup>, Lingjuan Zhang<sup>c,\*</sup>

<sup>a</sup> Department of Cardiothoracic Surgery, Changhai Hospital, Second Military Medical University, Shanghai, China

<sup>b</sup> Department of Health Statistics, Second Military Medical University, Shanghai, China

<sup>c</sup> Department of Nursing, Changhai Hospital, Second Military Medical University, Shanghai, China

## ARTICLE INFO

## Article history:

Received 23 November 2016

Accepted 24 February 2017

Available online 6 March 2017

## Keywords:

Postoperative delirium

Coronary artery bypass grafting

Risk factors

Nursing protocol

## ABSTRACT

**Objective:** The results of postoperative delirium (POD) warrant testing for prevention. The purpose of this study was to determine whether a nursing intervention targeting risk factors could decrease the incidence of POD among patients who had coronary artery bypass grafting (CABG) in China.

**Methods:** A prospective before-after study was conducted between April 2014 and April 2015. A nursing delirium intervention protocol targeting risk factors for delirium was performed for 141 patients undergoing CABG in a cardiothoracic ICU from November 2014 to April 2015. Intervention consisted of screening for delirium risk factors, followed by targeted risk factor modification, including pain control, early catheter removal, patient orientation using the 5W1H procedure, increased family visits, minimizing care-related interruptions, comfortable nursing and monitoring for sleeping difficulties. Outcomes of the Intervention Group were compared with those of the Control Group for 137 CABG patients from April 2014 to October 2014. Delirium was assessed using the confusion assessment method for the intensive care unit (CAM-ICU). The sample size was justified by PASS2000, based on previous data of delirium incidence in our institution (30%).

**Main results:** Delirium incidence during the first seven postoperative days was significantly lower in the Intervention Group at 13.48% (19/141) vs. 29.93% (41/137) for the Control Group ( $\chi^2 = 11.112$ ,  $P = 0.001$ ). In addition, POD in the Intervention Group occurred between the 3rd and 6th postoperative days, while POD in the Control Group mainly occurred on the first three days postoperatively. Delirium in the Intervention Group occurred later than delirium in the Control Group ( $\chi^2 = 12.743$ ,  $P < 0.001$ ). Length of ICU stay was reduced significantly ( $Z = -6.026$ ,  $P < 0.001$ ).

**Conclusion:** The application of a nursing protocol targeting risk factors in this study seems to be associated with a lower incidence of POD in patients after CABG. This finding suggests that managing the predictors properly is one of the effective strategies to prevent delirium.

© 2017 Chinese Nursing Association. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

## 1. Introduction

Delirium is a complex neuropsychiatric syndrome [1]. The patients may express hyperactive, hypoactive, or mixed psychomotor behaviors. Delirium has both significant short and long-term

adverse outcomes, risk for prolonged mechanical ventilation, increased inpatient mortality, prolonged hospital stay, increased odds of institutionalization following discharge and decreased cognitive functioning [2–4]. Coronary artery bypass grafting (CABG) is one of the effective methods for treating coronary artery disease, which has become an increasingly common disease with a poor prognosis. The patients are intensively cared for in the ICU during the early postoperative period. Postoperative delirium (POD) is important for CABG patients, and what makes POD important in CABG is not only its damaging effects but also its high

\* Corresponding author. Changhai Hospital, Second Military Medical University, 168 Changhai Road, Shanghai, 200433, China.

E-mail address: [18217301505@126.com](mailto:18217301505@126.com) (L. Zhang).

Peer review under responsibility of Chinese Nursing Association.

incidence. An incidence of POD ranging from 10% to more than 50% [5–8] was reported in different CABG patient groups. A prospective study in our cardiothoracic ICU demonstrated a POD incidence of 30.52% after CABG [9].

Therefore, prevention of delirium is essential. Prevention is proposed as a key to enhancing the quality of care. Studies have reported interventions aimed at reducing the delirium incidence in hospitalized patients. The interventional studies have focused on delirium screening, staff education, patient orientation, family interventions, use of volunteers or additional staff, physical environment control, pharmacological protocols and behavior management [10–13], and there was a trend for reduction in delirium in intervention groups. However, the evidence base remains limited, with variable interventions, inconsistent findings and a dearth of prospective studies. Additionally, the preventions mentioned above may not be generalized to postoperative patients, and further research of these strategies in postoperative patients is needed.

The risk of delirium increases with the number of risk factors present [13], and studies have shown positive patient outcomes by implementing risk factor-targeted interventions [13,14]. However, there was no thorough research on intervention programs targeting risk factors of POD after CABG, especially in China, which has a different context for nursing practice in other countries. We cultivated a nursing protocol targeting risk factors revealed by our previous study and conducted a before–after study to compare the effectiveness of the nursing protocol with that of a usual plan of care in our patients who had CABG. We hypothesized that this would decrease the incidence of delirium and thus reduce the length of ICU stay or hospital stay. We hope the study can guide clinical nursing care and improve quality of care for critically ill patients.

## 2. Methods

### 2.1. Overview of study development

We previously determined risk factors associated with POD of patients who had CABG [9]. In brief, among 49 risk factors, patients with and without delirium differed significantly in 34 variables ( $P < 0.05$ ). Multivariate logistic regression analysis revealed that six perioperative factors, namely preoperative atrial fibrillation, elevated European system for cardiac operative risk evaluation (EuroSCORE), cognitive impairment, prolonged surgery duration, postoperative poor quality of sleep and electrolyte disturbance, were independently associated with postoperative delirium after CABG. With the study result, we developed a checklist of 34 prevalent perioperative risk factors for delirium.

### 2.2. Study design

This study was undertaken in a cardiothoracic ICU of Changhai Hospital (2000 beds, Grade-III general teaching hospital). This study is a before–after study, conducted following TREND statement, and designed to assess the efficacy of a risk factor-targeted intervention program, in contrast to usual-care management, in preventing POD in patients who underwent CABG. The study was carried out in two stages. The first stage was the usual-care phase, and the second stage was the intervention stage, implementing the nursing delirium intervention protocol. Before the study, all nurses had been trained to assess delirium. Before the intervention stage of the study, the intervention protocol was developed, and staff education was fulfilled. Data were collected and entered twice into a computerized database (epidata3.1) by two research nurses, and the data had extensive checks for error and validity. Informed

consent to the study was obtained from all patients or patients' legally authorized representatives according to procedures approved by the institutional review board of the Changhai Hospital (CHEC 2014–199).

Eligible patients were 18 years old or older. They were included in the study when they stayed in the ICU more than 24 h. Patients were excluded with mental disease and delirium at admission, if they could not awaken from surgery within the first 24 h post-operatively, or if they could not understand Mandarin. The sample size was justified as follows. We expected a 50% reduction of POD incidence by implementing the intervention program in our CABG patients. Based on previous data from our institution in the same population (incidence of delirium was 30%), using the Power Analysis and Sample Size for Windows Software (PASS2000, NCSS, Utah, United States), 120 interventional subjects and 120 control subjects were needed for the study to be able to reject the null hypothesis with a power of 0.80 by the two-side paired *t*-test ( $\alpha = 0.05$ ). The type I error probability testing this null hypothesis was 0.1. Assuming a dropout rate of 20%, 144 patients per group would be potentially recruited.

Participants of this study were consecutive patients admitted to the cardiothoracic ICU after CABG from April 2014 until April 2015. The ICU has a capacity of 29 beds, admitting more than 2600 patients each year. Patients were divided into two groups. Patients who underwent CABG from April 2014 to October 2014 were assigned to the Control Group, which received usual care, while patients from November 2014 to April 2015 were assigned to the Intervention Group. The model for treatment was described previously [9], and there was no difference between the two groups over the study period. Patients stayed in the cardiothoracic ICU during the early postoperative period, and measurements were taken to prevent postoperative complications including arrhythmia, low cardiac output syndrome, hypoxia, hypotension and electric disturbances. The patients were on the mechanical ventilator via an oral endotracheal tube, sedated at 0–3 scores of the Richmond Agitation and Sedation Scale (RASS) [15], and had extubated intubation after meeting criteria for extubation according to the standard protocol. When the patients met the criteria of ICU discharge, they were transferred to the general ward.

A POD nursing intervention protocol was developed through patients' interviews and expert review. The quality of sleep was the strongest independent predictor of POD in our previous study [9]. The quality of sleep was influenced by several factors and with different factors for different situations. Therefore, we interviewed postoperative patients who were already discharged from the ICU and had not experienced POD in the ICU. Interviews were conducted in a quiet place without the presence of others and whenever they wanted and at a relaxed place. Three topics were the subject of the interview. They were as follows: ① How was your sleep in the ICU? ② Which factors influenced your sleeping quality in the ICU? ③ What can the ICU staff do to improve your sleeping quality? Sampling continued until data saturation and 15 patients participated in the study. The interview ranged between 25 and 45 min. Simultaneously with data collection, data analysis was performed according to the proposed procedure of Graneheim and Lundman [16]. There were several factors influencing patients' quality of sleep: wound pain and back pain, missing family members, confused about their current state, continuous lighting and loud noise, being interrupted by nursing activities, the dwelling of the nasogastric tube or the urinary catheter, thirsty, too hot or too cold, too early personal hygiene and a hard mattress, or a combination of personal and external factors.

Then, we studied and listed the evidence-based recommendations for six predictors of delirium, brain-stormed and drafted a POD nursing intervention protocol. Interventions were selected on

the consideration that they were amenable to be fulfilled in the context of our current nursing practice. Then, the nursing intervention protocol was developed by a multidisciplinary committee through expert review. The strategies were a set of specific targeted actions in seven domains and are shown in Table 1. Other than the nursing intervention, there were screen risk factors of delirium for all patients at hospital admission, the day before surgery and once a day postoperatively, with attention paid to the patients who had independent risk factors.

All of the ICU staff (nurses and physicians) was informed of the start of the intervention program. The performance of each staff member was evaluated by a checklist of actions to ensure full adherence to the protocols. A 150-min education session for the POD and POD intervention program was delivered by the research personnel to nursing staff before the intervention. Each topic was delivered three times to optimize shift workers' attendance. And it followed by a 20-min daily education during the intervention stage. A case-based forum of delirium prevention was facilitated weekly by the head nurse of the ICU. Care of the two groups was on the basis of usual care, which consisted of the standard care plan before the intervention program. If delirium developed, it was managed according to the ICU physician's order. The study did not interfere with daily care or treatment of any of the patients.

### 2.3. Study outcomes and data analysis

The primary outcome was incidence of POD. Secondary outcomes were subtype, severity, duration and the first episode of delirium episode, postoperative atelectasis, endotracheal reintubation, inpatient mortality, length of stay in ICU and length of overall hospital stay.

The confusion assessment method for the intensive care unit (CAM-ICU) [18] and RASS were used as validated scoring systems for delirium assessment. Delirium was screened according to CAM-ICU criteria with a two-step method [9]. Step 1 was to assess patients' consciousness by RASS. If a patient's RASS score was between  $-3$  and  $+4$ , then we proceeded to Step 2. If the RASS score was  $-4$  or  $-5$ , the patient was ineligible for CAM-ICU assessment. Step 2 was to assess delirium with the CAM-ICU. Its feasibility was good and can be detected in mechanical ventilation [18].

A delirium motoric subtype was defined for each CAM-ICU-positive assessment using the RASS score obtained from the current delirium assessment. Each delirium was categorized as hyperactive, hypoactive or mixed-type delirium. Delirium severity was

measured using the Delirium Rating Scale-Revised-98 (DSR-R-98) [19], a 16-item scale. Of the 16 items, 13 comprise the severity scale. The severity scale scores range from 0 to 39 and a cut-off score  $\geq 15$  is considered to be a delirious state. Delirium severity was categorized into three levels in this study: 15–21 indicated mild level of delirium, 22–30 indicated moderate delirium, and 31–39 indicated severe delirium. Duration of delirium was the number of days from the day of the first positive CAM-ICU assessment until recovery, which required two consecutive days of no delirium. The first episode of delirium is the day delirium developed.

All of the assessments were made by the patients' trained registered nurse (one registered nurse charged with 2 or 3 patients) and assured by ICU physicians. CAM-ICU assessment was trained continually over the study time to increase the compliance of nurses in administering the CAM-ICU as time passed by. As patients in early ICU were at high risk of developing delirium, patients in this study were assessed during a maximum of seven days postoperatively while staying in the ICU and were assessed three times a day or when the patient developed mental change. The inter-rater reliability of the assessment was 0.93, confirmed in 20 observations.

Baseline patient characteristics were compared and described using appropriate statistics. Categorical variables are presented as proportions (number, percentage), and analyzed between the intervention and control groups using the  $\chi^2$  test (Pearson chi-square test) or the Fisher's exact test, respectively, if expected cell counts were less than 5. Continuous variables are shown as means and standard deviation (S.D.) or medians and interquartile ranges (IQRs). Comparisons of continuous variables were performed between the two groups using Student's t-test for normally distributed variables and the non-parametric test for non-normally distributed variables. All tests were two-sided, and a  $p$ -value of  $<0.05$  was considered statistically significant. All data in this study were assessed with SPSS Statistics version 17.0 (SPSS, Chicago, Illinois, United States).

### 3. Results

A total of 278 patients were included in the study 137 in Control Group and 141 in Intervention Group. Table 2 shows the characteristics of the patients of the two groups. The main characteristics of the patients of the two groups showed no differences but for the number of distal anastomosis. Patients in the Intervention Group had more distal anastomosis than that of the Control Group.

**Table 1**

Intervention protocols for delirium: specific interventions in seven domains where some predictors are potentially preventable.

Specific measures	Standardized intervention strategies
Controlling pain to a mild level	Assess pain 5 times a day (06:00–10:00–14:00–18:00–21:30), recognize and manage pain that is higher than level 3 point with the Changhai Pain Scale [17].
Early catheter removal	Remove esophageal or urinary catheter as soon as possible by extubating the endotracheal tube early by ABCDE protocol.
Orientation using 5W1H	Orient all patients, three times a day (08:00–14:00–20:00) using 5W1H, including who (name of staff member caring for him/her), where (place and surrounding), when (date and time), what (what to do, or day's schedule), why (why do that) and how (how to do or how to cooperate). For patients with baseline cognitive impairment, implement three times a day.
More family visits	Increasing, extending and advancing family visits to twice a day, 30 min for each time, from 1st postoperative day, if no contraindication was evident. Family members were available for reorientation, cognitive activities and assistance with early activity.
Less care-related interruptions	Appropriate lighting and noise ( $<45$ FB); clustering nighttime nursing activities, avoid passive position changing and name being called during normal sleeping hours of 23:00–05:00, if possible.
Optimizing comfort	Room temperature was assessed and adjusted to 25° centigrade; personal hygiene was done at 20:00 before sleeping, not 14:00 in the afternoon; bed mattress was changed to be the reactive one; encourage drinking to prevent severe dryness, if not contraindicated.
Monitoring sleeping difficulties	If patients were assessed as unable to go to sleep at 23:00, this was reported to ICU physicians and patients were administered sedations or hypnotics, striving to let patients have a moderate level of sleep quality or an ordinary sleeping cycle. Dexmedetomidine hydrochloride was administered (0.2–0.7 mg/kg.h) to most of patients with poor quality of sleeping according to medical order.

**Table 2**  
Baseline characteristics and preoperative clinical parameters of the patients of the two study groups.<sup>d</sup>

Characteristic	Control group n = 137, n (%)	Intervention group n = 141, n (%)	Statistic-value	P-value
Age, years, mean (SD)	63.45 (9.26)	63.09 (8.49)	-0.338 <sup>a</sup>	0.368
Male gender	110 (80.29)	110 (78.01)	0.218 <sup>b</sup>	0.640
Education				
Illiteracy	13 (9.48)	12 (8.51)	0.159 <sup>c</sup>	0.873
Primary school	27 (19.71)	31 (21.99)		
Middle school or above	97 (70.80)	98 (69.50)		
Barrier of hearing or language	5 (3.65)	6 (4.26)	0.067 <sup>b</sup>	0.796
Alcohol use (3 months before operation)	58 (42.34)	55 (39.01)	0.319 <sup>b</sup>	0.572
Diabetes mellitus	46 (33.58)	54 (38.30)	0.673 <sup>b</sup>	0.412
Hypertension	80 (58.39)	86 (60.99)	0.195 <sup>b</sup>	0.659
Predisposing cerebral disease	10 (7.30)	11 (7.80)	0.025 <sup>b</sup>	0.874
Predisposing cardiac surgery	2 (1.46)	2 (1.42)	0.001 <sup>b</sup>	0.977
Renal dysfunction (creatinine >110 mg/dl)	13 (9.49)	11 (7.80)	0.251 <sup>b</sup>	0.616
AF	24 (17.52)	19 (13.48)	0.869 <sup>b</sup>	0.351
NYHA heart function				
Class I	6 (4.38)	4 (2.84)	-1.235 <sup>c</sup>	0.217
Class II	52 (37.96)	46 (32.62)		
Class III	76 (55.47)	87 (61.70)		
Class IV	3 (2.19)	4 (2.84)		
Cognitive impairment (MMSE < 27)	9 (6.57)	9 (6.38)	0.004 <sup>b</sup>	0.950
EuroSCORE, mean (SD)	3.04 (2.34)	2.91 (1.80)	-0.520 <sup>a</sup>	0.301
LVEF < 50%	23 (16.79)	20 (14.14)	0.360 <sup>b</sup>	0.548
Carotid artery plaque	50 (36.50)	49 (34.75)	0.092 <sup>b</sup>	0.761
MRS, mean (SD)	1.21 (0.56)	1.17 (0.46)	-0.652 <sup>a</sup>	0.258
Emergency operation	1 (1.46)	2 (1.42)	0.315 <sup>b</sup>	0.575
With CPB	129 (94.16)	134 (95.04)	0.104 <sup>b</sup>	0.747
Type of surgery				
CABG	113 (82.48)	115 (81.56)	0.040 <sup>b</sup>	0.842
CABG+	24 (17.52)	26 (18.44)		
Number for distal anastomosis				
one	23 (16.79)	19 (13.48)	-2.202 <sup>c</sup>	0.028
two	27 (19.71)	16 (11.35)		
three	55 (40.15)	59 (41.84)		
four	30 (21.90)	44 (31.21)		
five	2 (1.46)	3 (2.13)		
Surgery duration, min, mean (SD)	223.83 (72.23)	229.72 (67.13)	0.705 <sup>a</sup>	0.759

Abbreviations: BMI = body mass index; AF = atrial fibrillation; NYHA = New York Heart Association; MMSE = mini mental status examination; EuroSCORE = European system for cardiac operative risk evaluation; LVEF = Left ventricular ejection fraction; MRS = Modified Rankin Scale; CPB = Cardiac-pulmonary bypass; CABG = coronary artery bypass graft; CABG+ = have CABG and cardiac valve replacement, aortic repair or lung lobectomy simultaneously.

<sup>a</sup> t-test (t).

<sup>b</sup> Chi-square test ( $\chi^2$ ).

<sup>c</sup> Non-parametric test (Z).

<sup>d</sup> Data are presented as the number and the percentage (%) with the characteristic except where indicated.

**Table 3**  
Study outcomes.

Outcome	Control group n = 137, n (%)	Intervention group n = 141, n (%)	Statistic-value	P-value
Incident delirium, n (%)	41 (29.93)	19 (13.48)	11.112 <sup>a</sup>	0.001
Postoperative atelectasis, n (%)	20 (14.60)	12 (8.51)	2.528 <sup>a</sup>	0.112
Endotracheal reintubation, n (%)	4 (2.92)	2 (1.42)	0.754 <sup>a</sup>	0.385
Inpatient mortality, n (%)	5 (3.65)	5 (3.55)	0.002 <sup>a</sup>	0.963
Length of stay				
ICU days, median (IQRs)	3 (3,5)	3 (2,3)	-6.026 <sup>b</sup>	<0.001
hospital days, median (IQRs)	18 (15,22)	19 (16,22)	-1.045 <sup>b</sup>	0.296

<sup>a</sup> Chi-square test ( $\chi^2$ ).

<sup>b</sup> Non-parametric test (Z).

Study outcomes are shown in Table 3 and Table 4. Incidence of delirium in the Intervention Group was 13.48% (19/141), significantly lower than 29.93% (41/137) in the Control Group ( $P = 0.001$ ). The difference was statistically significant in terms of the first episode of delirium. POD in the Intervention Group occurred between the 3rd and 6th postoperative days, while POD in the Control Group mainly occurred on the first three days postoperatively ( $P < 0.05$ ). A comparison of other delirium profiles including delirium subtype, severity and duration of delirium episodes

between the two groups did not show statistical significance. Patients in the Intervention Group had a shorter length of ICU stay compared with patients in the Control Group ( $P < 0.001$ ). There were no significant differences in the incidence of postoperative atelectasis and endotracheal reintubation, inpatient mortality and length of hospital stay ( $P > 0.05$ ).

Of six independent risk factors, quality of sleep and electric disturbances were independent postoperative risk factors. The change in the two risk factors of the two groups was also studied.



**Table 4**  
Outcomes of delirium profiles of two study groups.

Outcome	Control group n = 41, n (%)	Intervention group n = 19, n (%)	Statistic-value	P-value
Subtype of delirium, n (%)				
Mixed delirium	18 (13.14)	7 (4.96)	0.284 <sup>a</sup>	0.868
Hypoactive delirium	9 (6.57)	5 (3.55)		
Hyperactive delirium	14 (10.22)	7 (4.96)		
Severity of delirium, n (%)				
Mild delirium	10 (7.30)	7 (4.96)	−0.792 <sup>b</sup>	0.428
Moderate delirium	21 (15.33)	8 (5.67)		
Severe delirium	10 (7.30)	4 (2.84)		
First episode of delirium				
Day of surgery–2nd postoperative day	34 (82.93)	7 (36.84)	12.743 <sup>a</sup>	<0.001
3rd ~ 6th postoperative day	7 (17.07)	12 (63.16)		
Duration of delirium				
One day	9 (6.57)	4 (2.84)	0.157 <sup>b</sup>	0.876
Two days	22 (16.06)	10 (7.10)		
Three days	6 (4.38)	3 (2.13)		
Four days	3 (2.19)	1 (0.71)		
Five days	1 (0.73)	1 (0.71)		

<sup>a</sup> Chi-square test ( $\chi^2$ ).<sup>b</sup> Non-parametric test (Z).

The quality of sleep demonstrated trends toward improvement in the Intervention Group, with 11 good (7.80%), 119 average (84.40%) and 11 poor (7.80%), compared with 3 good (2.19%), 99 average (72.26%) and 35 poor (25.55%) of the Control Group. Electrical balance was also associated with a trend toward improvement in the Intervention Group, with 28 (19.86%) patients compared with 55 (40.15%) patients in the Control Group.

#### 4. Discussion

Delirium was common in this sample of CABG patients with usual care, affecting 29.93% of eligible patients. As delirium was defined as the sixth vital sign [20], it deserved our attention. We cultivated a nursing intervention program targeting risk factors of delirium, and this study was to verify the efficacy of the intervention.

Data of our study demonstrated a reduction of the delirium incidence after implementation of the POD nursing protocol. Although the study design was not randomized, the reduction of delirium was marked given the almost-similar baseline demographics of intervention and control groups, in fact, distal anastomosis of the Intervention Group was more than that of the Control Group, which meant the condition of patients in the Intervention Group may have been more critical than that of the Control Group. Another important outcome was a moderate tendency towards a delayed onset of delirium, which could also be a consequence of the risk-targeted intervention. In this way, striving to let patients meet the criteria of ICU discharge and transfer them out of the ICU 48 h postoperatively became a goal of the ICU staff. However, the intervention had no significant effect on the subtype, severity and duration of delirium. The finding of the study has an important implication for the management of delirium, that is, primary prevention is effective. Once delirium has occurred, an intervention strategy will be less effective.

Delirium is a multifactor syndrome, resulting from the interaction of vulnerability on the part of the patient and hospital-related insults. The prevention of delirium has been demonstrated by modifying crucial risk factors [13]. Based on our previous study on risk factors of delirium, a standardized checklist of 34 prevalent perioperative risk factors for delirium was used to observe risk factors for delirium, thus raising delirium awareness. If the patients had one of six independent risk factors, the patient will be listed as high-risk, monitored carefully and reported between shifts. For

preoperative cognitive impairment (MMSE<24/30), psychological nursing had better psychological preparation. For preoperative AF, patients were given medical treatment according to the presentation of the arrhythmia, such as antithrombotic therapy, control ventricular rate and cardioversion. For a high EuroSCORE (>4 score), screening was done for newly admitted patients to detect those who are vulnerable. For a long surgery duration (operation time >120 min), maintaining an adequate blood flow after surgery was done. For poor quality of sleep, minimizing factors to influence sleep quality were done. For postoperative electrolyte disturbance [9], patients were monitored for occurrence by taking arterial blood gases two times each shift during ventilation and letting them fluctuate in the normal range according to doctor's orders.

The intervening protocol targeting risk factors of delirium was developed by patients' interviews, brain storming of nursing staff and expert review, on the basis of Guideline recommendations on delirium prevention and for the consideration that it could be fulfilled in our current nursing practice. Compared with usual care, our intervention protocol mainly focused on seven domains, including pain controlling, early catheter removing, orientation with 5W1H procedure, more family visits, minimizing care-related interruptions, optimizing comfort and monitoring sleep difficulties.

As pain was a contributing factor to sleep disturbance [21], we controlled pain to a relative bearable level. Pain was assessed for the postoperative patient twice per shift (8 h) in our ICU before the intervention, at 04:00–08:00–12:00 in the daytime and at night. Obviously, assessment at night will interrupt patients' sleeping. We adjusted the assessment to 5 times a day (06:00–10:00–14:00–18:00–21:30) in the Intervention Group. Because pain was not controlled well in the Control Group, even if they were already assessed regularly, we set a pain control criterion that if it was less than 4 points on the Changhai Pain Scale [17], the point would not affect the patient's sleep and mobilization. In case of pain (a Changhai Pain Scale higher than 3 point), effective doses of an analgesic medication, non-opioids or opioids, was given. We found that patients in the Intervention Group were more likely to receive analgesia than those in the Control Group. As the dual effects of opioid medications (analgesia and sedation), proper opioids used to control pain are protective against delirium whereas high doses used to cause sedation may increase the risk of delirium, we paid much attention to the usage of opioid analgesics.

Dwelling of the nasogastric tubes and urinary catheters caused throat pain and urinary stimulation, which are factors that

influence poor sleeping. Extubating the catheters as soon as possible became one of the strategies. In our study, all patients will be on a ventilator during the early postoperative stage, and nasogastric or urinary catheters were removed after the extubating of an endotracheal tube as the routine management protocol after a CABG procedure. Our previous study revealed that there were 18 (43.90%) patients who developed delirium during the ventilating period in the control group, and Cabello [22] reported that mechanical ventilation was associated with increased sleep architecture fragmentation. Therefore, an evidence-based strategy referred to as the ABCDE bundle [23] was undertaken in our study population. Other than delirium management, patients received awakening and breathing coordination and early mobility on a daily basis unless ICU physicians wrote an order not to have the patient participate in certain components of the ABCDE bundle. Though the duration of mechanical ventilation was not shortened significantly after intervention compared with that of the Control Group, there were only 5 (26.32%) patients who developed delirium during the ventilating period.

Preoperative cognitive impairment was the predictive factor for delirium in our study, and acute stress and anxiety could also cause poor sleep. For most patients in our study, this was the first stay in the ICU postoperatively, and they were always confused about the current situation. Contact directly with the environment could release the confusion. We orient patients using 5WIH procedures three times a day to let patients know their current state and how to cooperate accordingly.

As most patients noted that they wanted to see their family members or significant others when they opened their eyes, we increased, extended and advanced family visits. Family members were interviewed by register nurses before visiting, in order to educate them about how to orient the patient. If the patients were in a delirious state, then the visiting time was extended and the clinical features and prognostic implications of delirium were explained. Family members were accompanied by a nurse for the first 5 min of the visit. From the review of patients, we are certain that family visits contributed more to outcomes; however, it requires strong nursing leadership in a large ICU like ours, and it has not been sustained in our ICU now.

In the ICU, care-related interruptions were due to constant noise (e.g., equipment, staff) or frequent nursing practice in the evening. A study showed that a range of hospital sounds has a high disruptive capacity on sleep, influencing both cortical brain activity and cardiovascular function [24]. Creating a calm, comfortable environment, by normalizing day-night illumination, fulfilling the Three Quiet strategies (quiet chatting, quiet walking and quiet operating), we obtained a noise level of less than 45 FB especially in a large ICU setting like ours, minimizing care-related interruptions during the night, by achieving nurses working together, and avoiding unnecessary interventions during normal sleeping hours of 23:00–05:00. Comfortable nursing was executed in the Intervention Group also according to patients' suggestions.

Our study showed that nursing strategy targeting risk factors may have an effect on reducing the incidence of delirium. The positive trend in the reduction of modified independent risk factors with intervention compared with usual care suggested that risk-factor reduction contributed at least in part to the effectiveness of the intervention strategy.

The strengths of this study include a non-pharmacological approach based on patients' review, the detailed tracking of patients' orientation, the set objective of each strategy that staff would strive to meet and satisfactory patients' results with less incidence of delirium and a reduced length of ICU stay. The most important factor was that it was easy to merge the interventions into the daily work with the practical, realistic nature of the protocols.

Our study lent strong support to the use of a risk-targeting intervention to prevent delirium. Further evaluation is needed to determine the cost effectiveness of the intervention, its effects on related outcomes, such as re-hospitalization, institutionalization, and long-term cognitive functioning, and its effectiveness in heart surgeries or other settings. Our study got the strong effect, but this was our first trial to prevent delirium, challenge was thrown out to decrease the incidence of delirium further.

There are several limitations of this study. First, the study is not a random controlled study, so the result of the study may have been affected by time. However, the before-after prospective strategy prevented the contamination effect of the control group. Second, the study focused on a relatively short observation period, the effect of the intervention might be limited, and research with more patients may focus on the total length of stay in the ICU or in the hospital. Third, the present study included specific patients in our ICU, so the result will not generalize to all settings and to all patients.

## 5. Conclusion

Delirium is a deadly syndrome, being a state of confusion and disorientation with fluctuating intensity, often accompanied by medical illness and organ insufficiency. As delirium is a multifactorial syndrome, we cultivated a nursing intervention program targeting risk factors to reduce the incidence of delirium. This before-after study explored the effectiveness of the nursing intervention program in CABG patients. The CAM-ICU scale showed a marked reduction in POD in the Intervention Group. In addition, the intervention group had a shorter length of stay in the ICU. The trends to later onset of delirium were encouraging but must be interpreted with caution given that there were small research studies with the same result. In a word, this study clarified that recognition and avoidance or minimization of risk factors may effectively prevent the patient from developing delirium. This study helps us understand the best practice for applying evidence at the bedside.

## Conflict of interest statement

The authors declare no conflicts of interest in this work. ZWY obtained research funding, conceived the study with supervision of all authors. ZLJ, QWJ and LY supervised the conduct of the study, including quality control. SY, QWJ and ZGH collected data. YXF supervised the statistical analysis. All author approved the paper after critical reading.

## Funding source

The study was funded by the Committee of Health and Family Planning of Shanghai, China (project number 201440100). The views and opinions expressed herein are those of the authors.

## Acknowledgements

We are deeply appreciative of the patients and their families who made this study possible. We would like to thank and acknowledge the contributions from all the nurses and doctors from Department of Cardiothoracic Surgery, Shanghai Changhai Hospital.

## Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.ijnss.2017.02.002>

## References

- [1] Bucnerius J, Gummert JF, Borger MA, Walther T, Doll N, Falk V, et al. Predictors of delirium after cardiac surgery delirium: effect of beating-heart (off-pump) surgery. *J Thorac Cardiovasc Surg* 2004;127:57–64. <http://dx.doi.org/10.1016/S0022>.
- [2] McAvay GJ, Van Ness PH, Bogardus Jr ST, Zhang Y, Leslie DL, Leo-Summers LS, et al. Older adults discharged from the hospital with delirium: 1-year outcomes. *J Am Geriatr Soc* 2006;54:1245–50. <http://dx.doi.org/10.1111/j.1532-5415.2006.00815.x>.
- [3] Gottesman RF, Grega MA, Bailey MM, Pham LD, Zeger SL, Baumgartner WA, et al. Delirium after coronary artery bypass graft surgery and late mortality. *Ann Neurol* 2010;67:338–44. <http://dx.doi.org/10.1002/ana.21899>.
- [4] Koster S, Hensens AG, Schuurmans MJ, van der Palen J. Consequences of delirium after cardiac operations. *Ann Thorac Surg* 2012;93:705–11. <http://dx.doi.org/10.1016/j.athoracsurg.2012.02.003>.
- [5] Otomo S, Maekawa K, Goto T, Baba T, Yoshitake A. Pre-existing cerebral infarcts as a risk factor for delirium after coronary artery bypass graft surgery. *Interact Cardiovasc Thorac Surg* 2013;17:799–804. <http://dx.doi.org/10.1093/icvts/ivt304>.
- [6] Kazmierski J, Banys A, Latek J, Bourke J, Jaszewski R. Raised IL-2 and TNF-alpha concentrations are associated with postoperative delirium in patients undergoing coronary-artery bypass graft surgery. *Int Psychogeriatr/PA* 2013;1–11. <http://dx.doi.org/10.1017/S1041610213002378>.
- [7] Mu DL, Wang DX, Li LH, Shan GJ, Li J, Yu QJ, et al. High serum cortisol level is associated with increased risk of delirium after coronary artery bypass graft surgery: a prospective cohort study. *Crit Care* 2010;14:R238. <http://dx.doi.org/10.1186/cc9393>.
- [8] Rudolph JL, Jones RN, Grande LJ, Milberg WP, King EG, Lipsitz LA, et al. Impaired executive function is associated with delirium after coronary artery bypass graft surgery. *J Am Geriatr Soc* 2006;54:937–41. <http://dx.doi.org/10.1111/j.1532-5415.2006.00735.x>.
- [9] Zhang WY, Wu WL, Gu JJ, Sun Y, Ye XF, Qiu WJ, et al. Risk factors for post-operative delirium in patients after coronary artery bypass grafting: a prospective cohort study. *J Crit Care* 2015;30:606–12. <http://dx.doi.org/10.1016/j.jcrc.2015.02.003>.
- [10] Wand AP, Thoo W, Sciuriaga H, Ting V, Baker J, Hunt GE. A multifaceted educational intervention to prevent delirium in older inpatients: a before and after study. *Int J Nurs Stud* 2014;51:974–82. <http://dx.doi.org/10.1016/j.ijnurstu.2013.11.005>.
- [11] Martinez FT, Tobar C, Beddings CI, Vallejo G, Fuentes P. Preventing delirium in an acute hospital using a non-pharmacological intervention. *Age Ageing* 2012;41:629–34. <http://dx.doi.org/10.1093/ageing/afs060>.
- [12] Colombo R, Corona A, Praga F, Minari C, Giannotti C, Castelli A, et al. A reorientation strategy for reducing delirium in the critically ill. Results of an interventional study. *Minerva Anestesiol* 2012;78:1026–33. PMID: 22772860.
- [13] Inouye SK, Bogardus Jr ST, Charpentier PA, Leo-Summers L, Acampora D, Holford TR, et al. A multicomponent intervention to prevent delirium in hospitalized older patients. *N Engl J Med* 1999;340:669–76. <http://dx.doi.org/10.1056/NEJM199903043400901>.
- [14] Milisen K, Foreman MD, Abraham IL, De Geest S, Godderis J, Vandermeulen E, et al. A nurse-led interdisciplinary intervention program for delirium in elderly hip-fracture patients. *J Am Geriatr Soc* 2001;49:523–32. PMID: 11380743.
- [15] Sessler CN, Gosnell MS, Grap MJ, Brophy GM, O'Neal PV, Keane KA, et al. The Richmond Agitation-Sedation Scale: validity and reliability in adult intensive care unit patients. *Am J Respir Crit Care Med* 2002;166:1338–44. <http://dx.doi.org/10.1164/rccm.2107138>.
- [16] Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today* 2004;24:105–12. <http://dx.doi.org/10.1016/j.nedt.2003.10.001>.
- [17] Zhang CH, Hsu L, Zou BR, Li JF, Wang HY, Huang J. Effects of a pain education program on nurses' pain knowledge, attitudes and pain assessment practices in China. *J Pain Symptom Manag* 2008;36:616–27. <http://dx.doi.org/10.1016/j.jpainsymman.2007.12.020>.
- [18] Van Rompaey B, Schuurmans MJ, Shortridge-Baggett LM, Truijien S, Elseviers M, Bossaert L. A comparison of the CAM-ICU and the NEECHAM Confusion Scale in intensive care delirium assessment: an observational study in non-intubated patients. *Crit Care* 2008;12:R16. <http://dx.doi.org/10.1186/cc6790>.
- [19] Huang MC, Lee CH, Lai YC, Kao YF, Lin HY, Chen CH. Chinese version of the Delirium Rating Scale-Revised-98: reliability and validity. *Compr Psychiatry* 2009;50:81–5. <http://dx.doi.org/10.1016/j.comppsych.2008.05.011>.
- [20] Bellelli G, Trabucchi M. Delirium as the sixth vital sign. *J Am Med Dir Assoc* 2008;9:279. <http://dx.doi.org/10.1016/j.jamda.2007.08.014>.
- [21] Zeilani R, Seymour JE. Muslim women's narratives about bodily change and care during critical illness: a qualitative study. *J Nurs Scholarsh* 2012;44:99–107. <http://dx.doi.org/10.1111/j.1547-5069.2011.01427.x>.
- [22] Cabello B, Thille AW, Drouot X, Galia F, Mancebo J, d'Ortho MP, et al. Sleep quality in mechanically ventilated patients: comparison of three ventilatory modes. *Crit Care Med* 2008;36:1749–55. <http://dx.doi.org/10.1097/CCM.0b013e3181743f41>.
- [23] Balas MC, Vasilevskis EE, Olsen KM, Schmid KK, Shostrom V, Cohen MZ, et al. Effectiveness and safety of the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle. *Crit Care Med* 2014;42:1024–36. <http://dx.doi.org/10.1097/CCM.000000000000129>.
- [24] Buxton OM, Ellenbogen JM, Wang W, Carballeira A, O'Connor S, Cooper D, et al. Sleep disruption due to hospital noises: a prospective evaluation. *Ann Intern Med* 2012;157:170–9. <http://dx.doi.org/10.7326/0003-4819-157-3-201208070-00472>.