# Preoperative Education on Postoperative Delirium, Anxiety, and Knowledge in Pulmonary Thrombo-endarterectomy Patients

By Cassia Chevillon, RN, MSN, CCRN, Mary Hellyar, RN, MSN, CCRN, Catherina Madani, RN, MSN, Kim Kerr, MD, and Son Chae Kim, RN, PhD

**Background** Delirium is the most common postoperative psychiatric condition in intensive care settings and can lead to increased complications and costs.
**Objectives** To evaluate the impact of multifaceted preoperative patient education on postoperative delirium, anxiety, and knowledge and to explore predictors of postoperative delirium, days of mechanical ventilation, and days in the intensive care unit (ICU) in patients undergoing pulmonary thromboendarterectomy.
**Method** A prospective, randomized controlled trial was conducted on consented patients from October 2011 to April 2013. Patients were randomized in a 1 to 1 ratio to receive either an individualized 45-minute multifaceted preoperative education (experimental group, n = 63) or standard education (control group, n = 66). Participants completed the State-Trait Anxiety Inventory and Knowledge Test before and after the education. Data on incidence of delirium, days of mechanical ventilation, ICU days, and cardiopulmonary parameters were collected.
**Results** The experimental group had significantly more knowledge about postoperative care ($P < .001$) and fewer days of mechanical ventilation ($P = .04$) than the control group. The 2 groups did not differ significantly in anxiety, incidence of delirium, or ICU days. In exploratory multivariate analyses, hearing impairment was a positive predictor for days of delirium ($P = .009$), days of mechanical ventilation ($P < .001$), and ICU days ($P = .049$), whereas the posttest knowledge was a negative predictor for days of mechanical ventilation ($P = .02$).
**Conclusion** The patient education appeared to be effective in improving knowledge and reducing days of mechanical ventilation. Hearing impairment was an unexpected predictor of adverse outcomes for patients but may be amenable to nursing intervention. (*American Journal of Critical Care.* 2015;24:164-171)


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Delirium is the most common postoperative psychiatric condition, affecting up to 65% of all surgical patients and as many as 80% of patients in intensive care settings.[1] Postoperative delirium can lead to increased complications, functional decline after discharge, decreased long-term cognition, and increased mortality.[2] Delirium is also associated with an increased length of stay (LOS) and increased health care costs.[1,3-6] Medicare spends $6.5 billion a year for delirium-related in-hospital complications and an additional $100 billion in posthospital delirium-related costs such as nursing home care, rehabilitation, and home health care.[7]

Patients undergoing surgical procedures are also at increased risk for heightened anxiety, which is associated with a poorer postoperative recovery.[8,9] Preoperative anxiety is a common occurrence leading up to procedures in a hospital setting, owing to fear of the unknown and loss of control, and may cause an array of detrimental physiological effects.[8] Although the evidence identifying the risk factors for postoperative delirium and the effects of preoperative anxiety is substantial, little is known about the relationship between them.

Pulmonary thromboendarterectomy (PTE) is the only curative option for chronic thromboembolic pulmonary hypertension, which is caused by unresolved multiple pulmonary emboli that result in progressive right-sided heart failure.[10] PTE is an open-heart surgery requiring cardiopulmonary bypass and complete circulatory arrest to access and remove adherent, unresolved pulmonary emboli from the lining of the pulmonary artery lumen.[10,11] This surgery stops the progression of right-sided heart failure by reducing right ventricular afterload.[12]

Studies suggest that patients with high preoperative anxiety have more favorable outcomes when preoperative education is provided in a general surgery setting, but the impact of preoperative patient education for patients undergoing PTE has not been studied.[13-16] Although several modifiable risk factors for delirium have been identified, such as anticholinergic, sedative, and analgesic medications; age; dehydration; sleep deprivation; and mobility; preoperative anxiety has not been studied as a risk factor.[17] Finally, the effects of preoperative patient education on patients' outcomes, such as duration of mechanical ventilation and intensive care unit (ICU) LOS, have not been studied among PTE patients.


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## Methods

### Design and Consent

A prospective, randomized, nonblinded, controlled trial was carried out during an 18-month period to test whether a multifaceted preoperative educational program would decrease the incidence of postoperative delirium. Preoperative anxiety and knowledge regarding postoperative care were assessed, as well as patient outcome measures such as duration of mechanical ventilation and ICU LOS. The appropriate institutional review boards approved the study. Informed consent was obtained from recruited patients admitted for a PTE procedure who met eligibility criteria and agreed to participate. Enrolled participants were randomly assigned in a 1 to 1 ratio to either the experimental or control group.

> Delirium affects up to 65% of all surgical patients.

### Setting and Sample

The study was carried out at a 12-bed combined medical-surgical cardiovascular ICU at Sulpizio Cardiovascular Center, University of California San Diego Health System, from October 2011 to April 2013. Participants were recruited upon admission, 1 day before their surgery. Inclusion criteria included the following: age 18 years or older, male or female, English literate, and no prior PTE. Exclusion criteria included history of Alzheimer disease, dementia, or inability to give consent.

### Instruments and Data Collection

To evaluate the impact of multifaceted preoperative patient education, the following instruments were included: the State-Trait Anxiety Inventory, Confusion Assessment Method for Intensive Care Units, Knowledge Test, and a data collection form. All participants completed the State-Trait Anxiety Inventory and the Knowledge Test before and about an hour after receiving the preoperative education.

The State-Trait Anxiety Inventory comprises 2 scales, 1 that measures state anxiety and 1 that measures trait anxiety.[18] The 20-item state anxiety scale is used to assess the amount of apprehension and worry the individual feels at the moment on a 4-point Likert scale, ranging from 1 (not at all) to 4 (very much so). The 20-item trait anxiety scale is used to measure longer term, enduring anxiety on a 4-point Likert scale, ranging from 1 (almost never) to 4 (almost always). The summation score for each scale ranges from 20 to 80, and a higher score indicates greater anxiety. Cronbach $\alpha$ for the internal consistency reliability was 0.92 for the state anxiety scale and 0.90 for the trait anxiety scale.

To assess delirium, the Confusion Assessment Method for Intensive Care Units was used.[19] This tool has 4 components: (1) an acute onset of mental status changes or a fluctuating course, (2) inattention, (3) disorganized thinking, and (4) an altered level of consciousness as measured by the Richmond Agitation and Sedation Scale. Delirium is present if both components 1 and 2 are positive in addition to either component 3 or component 4.

"What to Expect of Your ICU Stay," was the part of the intervention educational session.

The 10-item Knowledge Test was developed by the investigators to assess the participants' knowledge about postoperative care. It includes questions on suctioning during mechanical ventilation, anticipated extubation, use of restraints, and prevention of pressure ulcers. Face validity of the question items was established with a panel of 7 experts in critical care.

The participants were interviewed to collect ethnicity, psychiatric and neurological history including anxiety or depression, vision status, and alcohol or illicit drug use. They were also asked about hearing impairment or use of hearing aid. The investigators also determined whether a support system (ie, family or friend) was present during the hospital admission. Additional demographic information, such as date of birth, sex, and other clinical variables were obtained from the participants' electronic medical records. The clinical variables included intraoperative and postoperative parameters up to the first 7 days after surgery or until ICU discharge.

### Intervention

Participants in the experimental group received an individualized 45-minute multifaceted educational session that was led by one of the study educators. All educators were experienced ICU nurses who underwent education training. Consistency in educational technique was established by requiring return demonstration of all educators. The education was titled, "What to Expect of Your ICU Stay," which included visual, tactile, kinesthetic, and auditory methods of teaching. The content of the education was focused on surgeries requiring a sternotomy and was not specific to the PTE procedure only. The nurse educators used a colorful handout written at a fifth-grade reading level that included multiple images. The educators described the sights, sounds, and nursing care to be anticipated postoperatively. Actual postoperative equipment was used for hands-on demonstrations during the educational session; that equipment included an endotracheal tube, a ventilator, restraints, venodynes, a Swan-Ganz catheter, and an incentive spirometer. The participants were also taken on a tour of the ICU.

The control group received the standard preoperative education, consisting of unstructured teaching by various members of the multidisciplinary team during preoperative clinic visits and after hospital admission. The content of the standard preoperative education was provider-dependent and was provided as a part of the informed consent process for the PTE surgery.

### Data Analysis

SPSS software version 20.0 (SPSS Inc) was used for all data analyses. Descriptive statistics of mean, median, standard deviation, frequency, and percentage were calculated for demographic and clinical variables. To compare the experimental and control groups, independent *t* tests and Fisher exact tests were used for continuous and dichotomous demographic/clinical variables, respectively. Independent *t* tests were performed to compare the changes in pretest and posttest trait anxiety, state anxiety, and knowledge scores for the experimental and control groups. Intention-to-treat analyses were used to compare the experimental and control groups.

To further explore the predictors of days of delirium, mechanical ventilation, and ICU stay, bivariate Pearson correlation analyses were initially performed between these 3 dependent variables and the independent demographic/clinical variables.

Dummy codes were assigned for categorical variables such as hearing impairment, history of alcoholism, anxiety, depression, posttraumatic stress disorder, and preoperative narcotics for chronic pain. The independent variables that had statistically significant correlations with 1 or more of the 3 dependent variables were selected as potential predictors. These statistically significant demographic and clinical variables were then entered simultaneously into multiple regression models. Two-sided statistical significance was set at .05 for all data analyses. Based on power analysis for 80% power and 2-sided significance level at .05, a total of 128 patients were needed to detect a 50% difference in delirium between the 2 groups.

## Results

### Sample Characteristics

Out of 215 patients undergoing PTE surgery during the study period, 143 patients were screened for the study. Eleven patients did not meet the inclusion criteria; the remaining 132 were randomized, 65 into the experimental group and 67 into the control group. Two patients from the experimental group and 1 from the control group were found to have a history of Alzheimer's disease or dementia after randomization and were excluded from data analyses. The study flow diagram is shown in Figure 1.

Demographic characteristics of the experimental and control groups are shown in Table 1. The mean age was 54 years old and most participants were female and white. About 9% of the participants reported hearing impairment or hearing aid use. Forty-three percent of the participants had other surgical procedures performed concurrently with PTE. Fisher exact tests showed no significant differences between the experimental and control groups except for support system presence during the educational session. Preoperative mean pulmonary artery pressure did not differ significantly ($P$=.83) between the experimental group (43.1 mm Hg) and the control group (43.6 mm Hg).

### Intraoperative and Postoperative Parameters

No statistically significant differences were observed in intraoperative parameters between the 2 groups (eg, total cardiopulmonary bypass time was 252 minutes for the experimental group and 254 minutes for the control group, $P$=.74). On postoperative day 1, the mean pulmonary artery pressure was lower for the experimental group than for the control group (20.4 mm Hg vs 22.8 mm Hg; $P$=.04), but the mean pulmonary artery pressure was not significantly different ($P$>.05) between the 2 groups on subsequent days.

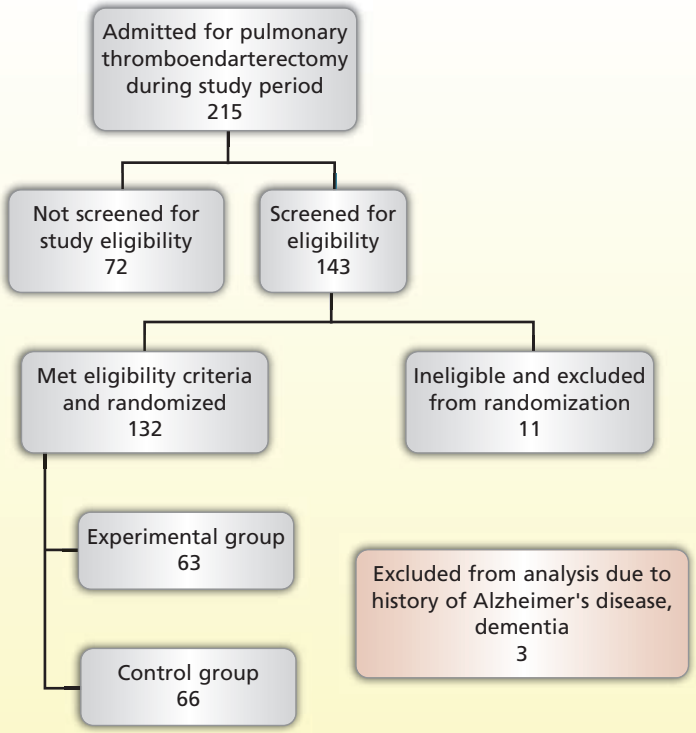


**Figure 1** Flow diagram of the study.

### Impact of Multifaceted Preoperative Patient Education

The incidence of delirium was 22.2% for the experimental group and and 31.8% for the control group, which was not significantly different ($P$=.24). Figure 2 depicts the percentage of patients with delirium on each of the 7 postoperative days.

The internal consistency reliabilities of the scales on the State-Trait Anxiety Inventory as measured by Cronbach α were 0.94 for the state anxiety scale and 0.91 for the trait anxiety scale. Figure 3 shows the mean differences in pretest and posttest trait anxiety, state anxiety, and knowledge scores for the experimental and control groups. For trait anxiety and state anxiety scores, the posttest scores decreased numerically for both the experimental group and the control group, but the mean changes did not differ significantly between the 2 groups ($P$=.97 for trait anxiety, $P$=.45 for state anxiety). The mean changes in knowledge scores, however, were significantly different between the 2 groups: the experimental group achieved greater improvements in knowledge than the control group achieved ($P$<.001).

### Days of Delirium, Mechanical Ventilation, and ICU Stay

The comparisons between the 2 groups are shown in Table 2. Mean days of delirium and mean days of ICU stay did not differ significantly between the

**Table 1**
**Sample characteristics**

| Characteristic[a] | Total sample (N = 129 ) | Experimental (n = 63 ) | Control (n = 66) |
|---|---|---|---|
| Age, mean (range), y | 54 (22-84) | 53 (25-84) | 55 (22-78) |
| Sex | | | |
| Female | 71 (55) | 33 (52) | 38 (58) |
| Male | 58 (45) | 30 (48) | 28 (42) |
| Ethnicity | | | |
| White | 87 (67) | 47 (75) | 40 (61) |
| Black | 25 (19) | 8 (13) | 17 (26) |
| Hispanic | 10 (8) | 6 (10) | 4 (6) |
| Asian | 3 (2) | 1 (2) | 2 (3) |
| Other | 4 (3) | 1 (2) | 3 (4) |
| Support system presence[b] | 121 (94) | 62 (98) | 59 (89) |
| Hearing impairment | 11 (9) | 5 (8) | 6 (9) |
| History of alcohol use | 49 (38) | 26 (41) | 23 (35) |
| Alcoholism | 3 (2) | 1 (2) | 2 (3) |
| Anxiety | 19 (15) | 8 (13) | 11 (17) |
| Depression | 21 (16) | 10 (16) | 11 (17) |
| Posttraumatic stress disorder | 5 (4) | 3 (5) | 2 (3) |
| Preoperative narcotics use for chronic pain | 14 (11) | 9 (14) | 5 (8) |
| Preoperative use of anxiolytics | 13 (10) | 6 (10) | 7 (11) |
| Preoperative use of psychiatric medications | 14 (11) | 6 (10) | 8 (12) |
| Preoperative pulmonary artery pressure, mean (SD), mm Hg | 43.4 (13.3) | 43.1 (14.6) | 43.6 (12.1) |
| Pulmonary thromboendarterectomy and additional surgical procedures (coronary artery bypass graft, valve repair, repair of atrial septal defect, and others) | 55 (43) | 28 (44) | 27 (41) |

[a] Values are expressed as number (percentage) unless otherwise indicated. Percentages may not total 100 because of rounding.
[b] Fisher exact tests and independent *t* tests were used for categorical and continuous variables, respectively. The only characteristic that differed significantly ($P = .04$) between experimental and control groups was support system presence.

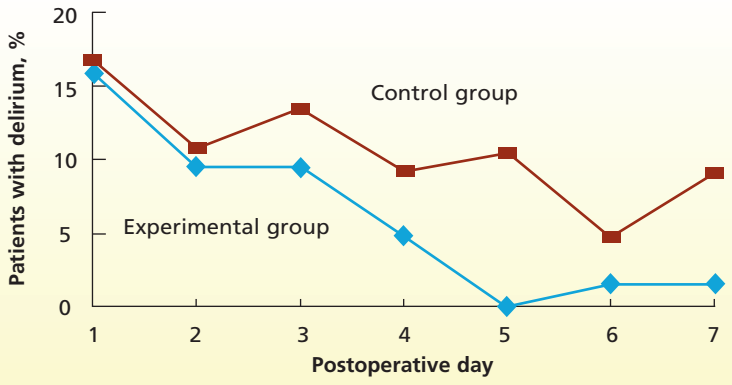


**Figure 2** Percentage of patients with delirium during the first 7 postoperative days.

groups; however, the experimental group had significantly ($P = .04$) fewer mean days of mechanical ventilation than the control group.

### Predictors for Days of Delirium, Mechanical Ventilation, and ICU Stay

Among the independent demographic and clinical variables, white ethnicity, hearing impairment, support system presence, preoperative use of narcotics for chronic pain, preoperative use of psychiatric medications, preoperative mean pulmonary artery pressure, preoperative pulmonary vascular resistance, and medical history of anxiety, depression, and posttraumatic stress disorder had statistically significant ($P < .05$) correlations with 1 or more of the dependent variables. In addition, the posttest knowledge score had a statistically significant negative correlation with the days of mechanical ventilation ($r = -0.26$; $P = .01$), whereas the posttest state anxiety and posttest trait anxiety scores had no correlations with any of the dependent variables. All the significant variables were entered simultaneously into the multiple regression models to explore the predictors of days of delirium, days of mechanical ventilation, and days of ICU stay. Table 3 shows the results of the simultaneous regression models. Since the preoperative mean pulmonary artery pressure and pulmonary vascular resistance were collinear, preoperative pulmonary vascular resistance was not included as a potential predictor in the simultaneous multiple regression models. Model assumptions of normality, linearity, and homoscedasticity were met.[20]

For days of delirium as the dependent variable, the potential predictors explained 17% of the variance ($R^2 = 0.17$). Among the predictors, white ethnicity ($\beta = 0.21$; $P = .02$), hearing impairment ($\beta = 0.24$; $P = .009$), and preoperative mean pulmonary artery pressure ($\beta = 0.21$; $P = .02$) reached statistical significance. For the days of mechanical ventilation, the predictor variables explained 30% of the variance ($R^2 = 0.30$). White ethnicity ($\beta = 0.21$; $P = .01$), hearing impairment ($\beta = 0.36$; $P < .001$), preoperative mean pulmonary artery pressure ($\beta = 0.25$; $P = .003$), and posttest knowledge ($\beta = -0.20$; $P = .02$) were the statistically significant predictors for days of mechanical ventilation. Finally, for the days of ICU stay as the dependent variable, the potential predictors explained 38.2% of the variance ($R^2 = 0.38$). Among predictor variables, hearing impairment ($\beta = 0.16$; $P = .049$), preoperative mean pulmonary artery pressure ($\beta = 0.25$; $P = .002$), posttraumatic stress disorder ($\beta = 0.40$; $P = .001$), and depression ($\beta = 0.16$; $P = .048$) reached statistical significance.

## Discussion

In this randomized controlled trial, multifaceted preoperative patient education did not reduce the incidence of postoperative delirium or reduce preoperative anxiety among patients undergoing PTE. However, the education improved patients' knowledge about postoperative care and decreased mechanical ventilation duration from 2.4 days for the control group to 1.6 days for the experimental group.

To identify potential predictors of patients' outcomes, 3 exploratory multivariate analyses were performed. For duration of mechanical ventilation, patients' knowledge of postoperative care before undergoing surgery was a significant predictor, with better knowledge scores predicting shorter ventilation days. It was surprising that hearing impairment was a significant predictor of all 3 outcome variables, increasing the duration of mechanical ventilation as well as ICU LOS and days of delirium. This finding highlights the importance of nurses prioritizing reestablishment of preoperative sensory baseline in the ICU. Nurses can help by ensuring that patients have their hearing aids properly placed and activated in the ICU during waking hours and before initiating the weaning process. This simple procedure should be a part of the standard nursing practice that could lead to improved outcomes for patients with hearing impairment. However, further research is needed to confirm the effects of hearing impairment on duration of mechanical ventilation and the generalizability of these findings to other ICU settings.

The current study supports the previous study findings that preoperative education increases knowledge.[21] It is plausible that the knowledge gained through preoperative education allowed the participants to anticipate their postoperative environments and procedures, perhaps enabling better adaptation to postoperative stress. However, it is not clear which components of the multifaceted education were most beneficial in increasing participants' knowledge. In addition, the educational sessions were time intensive and provision of additional ICU nursing staff resources was required for implementation.

Elevated preoperative mean pulmonary artery pressure was also a predictor of delirium, duration of mechanical ventilation, and ICU LOS. Mean pulmonary artery pressure is an expected contributor to these outcomes, as increased pulmonary artery pressures denotes an advanced disease process at baseline. Langer et al[22] reported that patients undergoing PTE surgery with high baseline pulmonary pressures had an increased inflammatory response leading to prolonged ICU stay. Additionally, severe illness and inflammatory response are known risk

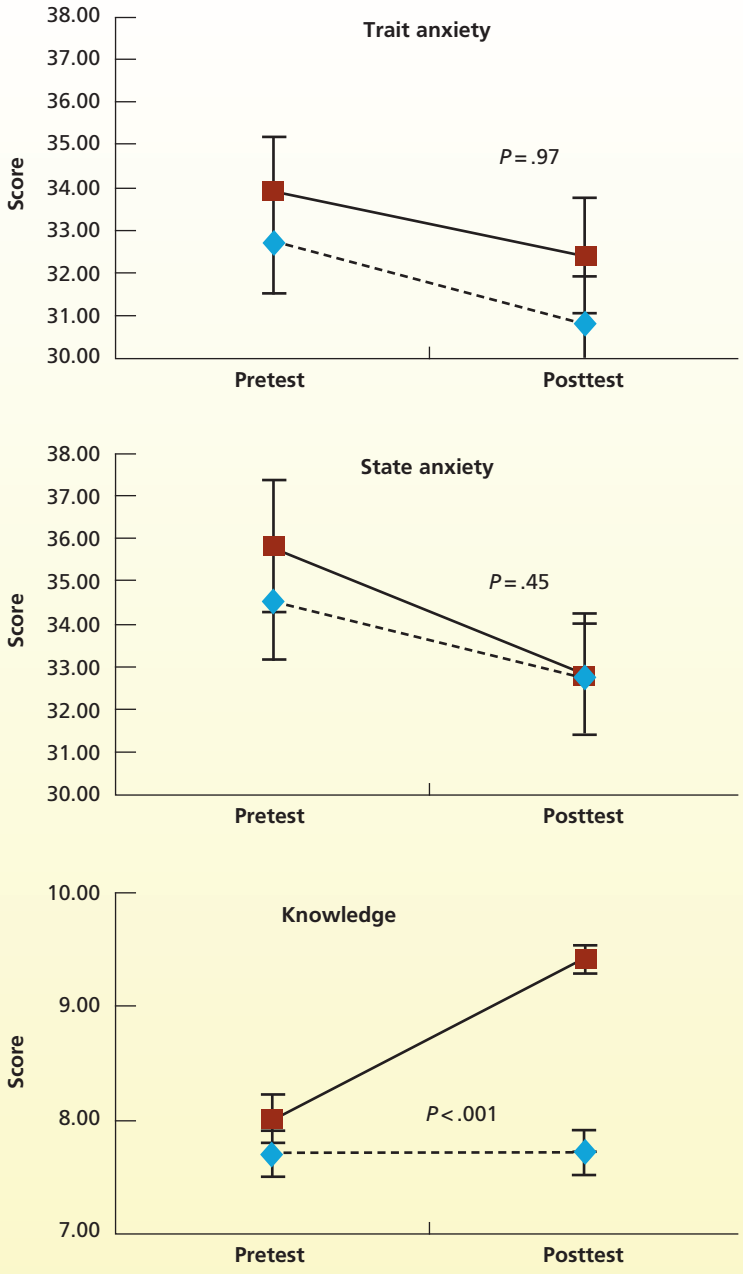


**Figure 3** Mean (SEM) scores on pretest and posttest (N = 129). Solid line indicates the experimental group and dashed line indicates the control group.

**Table 2**
**Comparison of outcome measures**

| Outcome measure | Total sample (N = 129 ) | Experimental (n = 63 ) | Control (n = 66) | *P* |
|---|---|---|---|---|
| Days of delirium, mean (SD) | 0.6 (1.3) | 0.4 (1.1) | 0.7 (1.4) | .16 |
| Days of mechanical ventilation, mean (SD) | 2.0 (2.3) | 1.6 (1.7) | 2.4 (2.6) | .04 |
| Days in intensive care unit, mean (SD) | 5.1 (6.9) | 4.2 (2.9) | 5.9 (9.2) | .17 |

**Table 3**
**Simultaneous multiple regression models**

| Predictors | Days of delirium | | Days of mechanical ventilation | | Days in intensive care unit | |
|---|---|---|---|---|---|---|
| | β | *P* | β | *P* | β | *P* |
| White ethnicity | 0.21 | .02 | 0.21 | .01 | -0.08 | .30 |
| Hearing impairment | 0.24 | .009 | 0.36 | <.001 | 0.16 | .049 |
| Preoperative mean pulmonary artery pressure | 0.21 | .02 | 0.25 | .003 | 0.25 | .002 |
| Posttraumatic stress disorder | 0.04 | .43 | -0.01 | .88 | 0.40 | <.001 |
| Depression | 0.05 | .66 | 0.03 | .77 | 0.16 | .048 |
| Posttest knowledge | -0.11 | .22 | -0.20 | .02 | 0.02 | .22 |
| | $R^2 = 0.17$<br>$F_{9,112} = 2.61$<br>($P = .009$) | | $R^2 = 0.30$<br>$F_{9,112} = 5.47$<br>($P < .001$) | | $R^2 = 0.38$<br>$F_{9,112} = 7.70$<br>($P < .001$) | |

factors of delirium.[17,23] Previous research also demonstrated a statistically significant association between severity of preoperative pulmonary hypertension (mean pulmonary artery pressure and pulmonary vascular resistance) and the development of postoperative lung injury, which may lead to prolonged ventilation.[24]

Operative time and pump time were not predictors of delirium—contrary to the common ICU belief associated with the term "pump brain." This result could be attributed to multiple factors including advances in mechanisms for preserving brain perfusion and in cardiac anesthesia and could be indicative of our center's experience in caring for patients who require this level of care.[25] Further research is needed on the impact of prolonged pump and operative time in patients undergoing PTE.

Numerous surgeries require mechanical ventilation postoperatively. Many of these patients receive postoperative ICU care and ventilation weaning similar to what was experienced by the participants in this study. They also are subject to many of the same postoperative complications. Although the multifaceted education did not affect the postoperative delirium, it may nevertheless provide an opportunity for nurses to influence other outcomes for surgical patients such as duration of mechanical ventilation. Further research is needed to explore the benefits of education on other surgical procedures to confirm the results of this study.

## Limitations

The current study had several limitations. First, it was a single-center study, which may limit the generalizability of the results. In addition, although PTE surgeries parallel many aspects of general open-heart cardiac surgeries, their distinct characteristics may limit the generalizability of current study findings beyond PTE surgeries. Second, support system presence during the educational sessions differed significantly in the 2 randomized groups, potentially biasing the results. Third, the daily delirium assessments were performed by a large number of bedside nurses, and the interrater reliability of assessments had not been validated. Fourth, the lack of double-blinding may have introduced bias. Finally, because of the limited time between hospital admission and surgery the following morning, the participants may not have had adequate time to assimilate the preoperative education.

## Conclusions

The multifaceted preoperative education did not affect postoperative delirium, but it appeared to improve postoperative knowledge and reduce the days of mechanical ventilation among patients who had undergone PTE. Hearing impairment was an unexpected predictor of postoperative delirium, prolonged mechanical ventilation, and longer ICU stay, and hearing impairment may be easily amenable to nursing intervention.

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FINANCIAL DISCLOSURES
None reported.

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