Randomized Controlled Trial: Evaluation of Multifaceted Preoperative Patient Education on Anxiety, Delirium, Knowledge and Patient Satisfaction among Post-Pulmonary Thromboendarterectomy Patients

by

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A Thesis Presented to the

FACULTY OF THE SCHOOL OF NURSING

POINT LOMA NAZARENE UNIVERSITY

In partial fulfillment of the

Requirements for the degree

MASTER OF SCIENCE IN NURSING

July 2013

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Acknowledgements

I would first like to thank my family and friends for their support during my pursuit of a graduate degree at Point Loma Nazarene University. Their words of encouragement kept me moving forward during challenging times. Thank you for not giving up and for understanding when my studies encroached on family time.

To Dr. Son Chae Kim, an unbelievable committee member and mentor, thank you for believing in this study and for your encouragement to do something big. This study would not have been completed without your patience, guidance, and expertise.

To Dr. Kim Kerr, the medical director of Thornton ICU at UCSD, thank you for your encouragement and guidance throughout this process. You helped to clear and blaze the path, and provided encouragement and reassurance when the obstacles seemed impossible. This would not have been possible without you.

To Dr. Larry Rankin, Professor Deana Noble, and Dr. Jeanie Maiden, thank you for your input, and mentorship. You are all great examples of professional nurses, teachers, and researchers.

Finally, I would like to acknowledge and thank the many UCSD nurses who helped with this study; Toni Moseley, Catherina Madani, Sherry Carreau, Laura Martin, Carie Helm, Alex Whalen, Kelly Barber, and Lina Rossetti-Grulich, you made this project possible. Your willingness to come in on your days off, your steadfastness, and your eagerness to learn, did not go un-noticed. I thank you from the bottom of my heart!

Abstract

This prospective, randomized controlled trial was conducted to evaluate the impact of multifaceted preoperative patient education on anxiety, knowledge, satisfaction, and postoperative delirium, and to explore the predictors of delirium, mechanical ventilation, and intensive care unit (ICU) length of stay. Consented patients undergoing pulmonary thromboendarterectomy from October 2011 to April 2013 were randomized in 1:1 ratio to receive either an individualized 45-minutes multifaceted preoperative education (experimental group, n=63) or standard education (control group, n=66). Participants completed knowledge Test and the State-Trait Anxiety Inventory before and after the education. Patient satisfaction, delirium, mechanical ventilation, ICU length of stay, and cardiopulmonary parameters were collected. The experimental group had significant improvement in postoperative care knowledge (p<0.001) and fewer days on mechanical ventilation (p=0.038) compared to the control group. No statistically significant differences were observed in anxiety, satisfaction, length of ICU stay, and incidence of delirium. In exploratory multivariate analyses, hearing impairment was a statistically significant positive predictor for days of delirium (p=0.009), days of mechanical ventilation (p<0.001), and ICU length of stay (p=0.049); whereas the posttest knowledge was a statistically significant negative predictor for days of mechanical ventilation (p=.018). The multifaceted preoperative patient education appeared to be effective in improving knowledge, lowering incidence of delirium, and reducing days of mechanical ventilation. Hearing impairment was an unexpected negative predictor of patient outcomes, which may be amenable to nursing intervention.

Key words: delirium, preoperative education, knowledge, anxiety

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Introduction

Delirium may be 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 (Jackson, Gordon, Hart, Hopkins, & Ely, 2004). Delirium can lead to increased complications, functional decline after discharge, decreased long-term cognition, and increased mortality (Wong, Holroyd-Leduc, Simel, & Straus, 2010), highlighting it as a major health problem. Delirium is associated with an increased three day length of stay in the intensive care unit (ICU) (Ely et al., 2004; Rudolph et al., 2010; Schuurmans, Shortridge-Baggett, Truijen, Elseviers, & Bossaert, 2009; Van Rompaey et al., 2009), and overall hospital stay of up to 10 days (Jackson, et al., 2004). Increased cost associated with ICU delirium are up to 39% (Milbrandt et al., 2004). Medicare disperses 6.5 billion dollars a year for delirium-related in-hospital complications, and an additional $100 billion is spent in post-hospital delirium-related costs such as nursing home care, rehabilitation, and home health care (Rubin, Neal, Fenlon, Hassan, & Inouye, 2011).

Patients undergoing surgical procedures are also at increased risk for heightened anxiety, which is associated with a poorer recovery (Pritchard, 2009; Scott, 2004). Preoperative anxiety is a common occurrence leading up to procedures in a hospital setting due to fear of the unknown and loss of control (Pritchard, 2009). Anxiety may cause an array of physiological effects including tachycardia, hypertension, hyperthermia, and nausea. It can also lower a patient's immunity, prolonging healing times and lengthening hospital stay (Pritchard, 2009). Although there is substantial evidence identifying the risk factors and effects of delirium and anxiety, little is known about the relationship between them.

Pulmonary Thromboendarterectomy (PTE), a surgical procedure developed and performed at University of California San Diego Medical Center in southern California, USA, is the only curative option for chronic thromboembolic pulmonary hypertension (CTEPH), a form of pulmonary hypertension caused by unresolved pulmonary emboli. This surgery stops the progression of right heart failure by removing the adherent tissue from the pulmonary arterial lumen, thus reducing right ventricular afterload (Skoro-Sajer et al., 2009). PTE surgery is an open-heart surgery requiring cardiopulmonary bypass and complete arrest to perform an effective endarterectomy (Auger, Kim, Kerr, Test, & Fedullo, 2007; Madani & Jamieson, 2006). Mortality rates of post-PTE surgery patients range from 4-24%, depending on distal proximity of the clot arrangements (Lang & Klepetko, 2008) and preoperative pulmonary vascular resistance (PVR). Patients undergoing the PTE surgery are predisposed to developing anxiety related to their ICU stay, potential pain, loss of control, and lack of understanding. They are also at high risk for developing postoperative delirium. It is imperative that the risk factors for anxiety and delirium are identified, and measures for prevention are taken.

Studies suggest that patients with high preoperative anxiety have more favorable outcomes when preoperative education is provided and preoperative education has shown to increase psychological wellbeing and patient knowledge, when provided the day before surgery (Deyirmenjian, Karam, & Salameh, 2006; Shuldham, 1999). Kruzik (2009), reports that pre-operative education leads to a reduction in hospital complications, length of stay, and the need for pain medications. It also increases patient and family satisfaction (Kruzik, 2009). Postoperative cardiac patients have been shown to recover quicker and have less incidence of hypertension when given preoperative education (Garretson, 2004).

The American Medical Association (AMA) acknowledges the importance of patient education, recommending that patients receive a combination of individualized verbal instruction along with visual education such as handouts, tip cards, and other literacy resources (AMA, 2011). The Institute of Healthcare Improvement (IHI) also endorses the importance of patient education, stressing that only 12% of American adults have proficient health literacy (2013). The IHI recommends educational material be presented at a 5th grade reading level (Institute for Healthcare Improvement, 2013).

Education may be the key to improving patient outcomes and satisfaction. Addressing patients' psychosocial needs and empowering them can decrease complications, be cost effective, and improve outcomes (Pritchard, 2009). Overall patient satisfaction occurs when the following factors are properly addressed: "timeliness, attitude, information, explanation, body language, physical touch, and contextual sounds and sights" (Chilgren, 2008). Patient satisfaction is important as patients who are satisfied with their care tend to more readily participate in their care treatments, are more likely to recommend the hospital that they are in to family and friends, and are more likely to choose the hospital that they are in for future visits (Findik, Unsar, & Sut, 2010).

The impacts of a preoperative patient education for patients undergoing PTE have not been studied. Although several modifiable risk factors for delirium have been identified, such as anticholinergic, sedative and analgesic medications, age, dehydration, sleep deprivation, and mobility (Olson, 2012), preoperative anxiety has not been studied as a risk factor. Furthermore, the effects of preoperative patient education upon patient outcomes, such as patient satisfaction, mechanical ventilation, and ICU length of stay, have not been studied among PTE patients.

Methods

Aims

The aims of this randomized controlled trial were to: (a) evaluate the impacts of multifaceted preoperative patient education on patient anxiety, knowledge, satisfaction and postoperative delirium; (b) compare the days of postoperative delirium, mechanical ventilation and ICU length of stay between the experimental and control groups; and (c) explore the predictors of delirium, mechanical ventilation and ICU length of stay among patients undergoing pulmonary thromboendarterectomy.

Design

A prospective, randomized controlled trial was carried out at a 12-bed combined medical-surgical ICU, at the University of California San Diego Medical Center, in southern California, from October 2011 to April 2013. The patients admitted for a PTE procedure were recruited and consented to the study. The participants were randomly assigned in 1:1 ratio to either the experimental or control group.

Participants in the experimental group received an individualized 45-minute educational session that was led by one of the study educators who were experienced ICU nurses. The educators were trained by the principal investigators and return demonstration was required to establish consistency among the educators. The education was titled, "What to Expect of your ICU Stay", which included visual, tactile, kinesthetic, and auditory modalities of teaching. The nurse educators used a colorful handout written at a fifth grade reading level that included multiple images. The nurse described the sights, sounds, and nursing care to be anticipated postoperatively. Actual postoperative equipment was utilized for hands-on demonstrations during the educational session including an endotracheal tube, 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.

Participants

The study participants were recruited upon admission the day prior to their surgery. The study inclusion criteria were: (a) age of 18 years or older; (b) male or female; (c) English literacy; and (d) PTE surgery for the first time. The patients were excluded if patients had: (a) history of Alzheimer's disease or dementia, (b) prior PTE surgery; (c) inability to give consent; or (d) insufficient English literacy.

Instruments

To evaluate the impacts of multifaceted preoperative patient education, the following instruments were included: the State-Trait Anxiety Inventory (STAI), Knowledge Test, Patient Satisfaction with Health Care Provider Scale (PSHCPS), Confusion Assessment Method for Intensive Care Units (CAM-ICU), a structured interview questionnaire, and a data collection tool.

The STAI (Spielberger, Gorsuch, Luchene, Vagg, & Jacobs, 1983) comprised of two scales, State anxiety and Trait anxiety. The 20-item State Anxiety scale assesses the amount of apprehension and worry the individual feels due to current circumstances on a 4-point Likert scale, ranging from 1 (*not at all*) to 4 (*very much so*). The 20-item Trait Anxiety scale measures how much anxiety is represented by the individual's personality which is a more enduring or permanent 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. The Cronbach's alphas of the internal consistent reliabilities were 0.92 and 0.90 for State Anxiety and Trait Anxiety scales, respectively.

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

The four-item general satisfaction subscale of the PSHCPS (Appendix B) measures the patients' level of satisfaction with the care received on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) (Cherkin, Hart, & Rosenblatt, 1988). The internal consistency reliability was reported with Cronbach's alpha of 0.88.

The investigators-developed study tool comprised of the structured interview questionnaire and a data collection form (Appendix C). The structured interview questionnaire was used at the time of study enrollment to obtain information regarding demographic data such as date of birth, gender, ethnicity, psychiatric history, brain injury history, hearing and visual status, and alcohol or illicit drug use. The data collection form was utilized to obtain the information from the participants' electronic medical records regarding the intra- and postoperative variables such as cardiopulmonary bypass time, circulatory arrest time, and anesthetics and pain medication given. Throughout the first seven days after surgery or until ICU discharge, information was extracted from the electronic medical records regarding daily delirium screening, hemodynamics, postoperative complications, mechanical ventilation use, and ICU discharge.

To detect delirium, the Confusion Assessment Method for Intensive Care Units (CAM-ICU) was utilized (Ely et al., 2001). The CAM-ICU has four features: (1) an acute onset of mental status changes or a fluctuating course (Glascow Coma or sedation scores over 24 hours and family or nurse report); (2) inattention (attention screening examinations or vigilance a random letter test); (3) disorganized thinking (disorganized/ incoherent thinking and following commands); and (4) an altered level of consciousness. Delirium is present if the assessment is positive for both features 1 and 2 in addition to either feature 3 or 4. The level of consciousness was assessed using the Richmond Agitation and Sedation Scale (RASS).

Data collection procedures

This study was reviewed and approved by the Institutional Review Boards at the medical center and the university (Appendices D & E). An informed consent was obtained from each patient who voluntarily agreed to participate in the study (Appendix F). Each participant was assigned a unique study number and randomized in a 1:1 ratio to either the experimental or the control group.

All participants were interviewed to complete the demographic form. They were asked to complete the STAI questionnaire and Knowledge Test before and after the preoperative educational session. The participants in the experimental group received the multifaceted preoperative patient education while the control group received the standard preoperative patient education. For the first seven postoperative days or until ICU discharge, the study investigators completed the data collection form by extracting the information from the electronic medical records. Before discharge from the ICU, every participant was asked to complete the PSHCP.

Data analyses

SPSS software version 20.0 (SPSS Inc., Chicago, IL.) was used for data analysis and data entry was double-checked for accuracy. 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's exact tests were used for continuous and dichotomous demographic/clinical variables, respectively. Independent *t*-tests were performed to compare the changes in pre- and posttest trait anxiety, state anxiety, and knowledge scores for the experimental and control groups and posttest scores of patient satisfaction. Intention-to-treat analyses were used to compare the experimental and control groups.

To explore the predictors of days of delirium, mechanical ventilation, and ICU length of stay, bivariate Pearson's correlation analyses were initially performed between these three dependent variables and the independent demographic/clinical variables. Dummy codes were assigned for categorical variables, such as hearing impairment, history of alcoholism, anxiety, depression, PTSD and preoperative narcotics, as well as the educational intervention (e.g. 1=yes; 0=no) as independent variables. The independent variables that had statistically significant correlations with one or more of the three dependent variables were selected as potential predictors. The statistically significant demographic/clinical variables were then entered simultaneously into multiple regression models. Two-sided statistical significance was set at 0.05 for all data analyses. A total of 128 patients were needed to detect a 50% difference in delirium between the two groups based on power analysis for 80% power and 2-sided significance level at 0.05.

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 remaining132 were randomized: 65 into experimental and 67 into control group. Two patients from the experimental group and one from the control group were found to have a history of Alzheimer's disease or dementia after randomization. These ineligible patients were excluded from data analyses. The study flow diagram is shown in Figure 1.

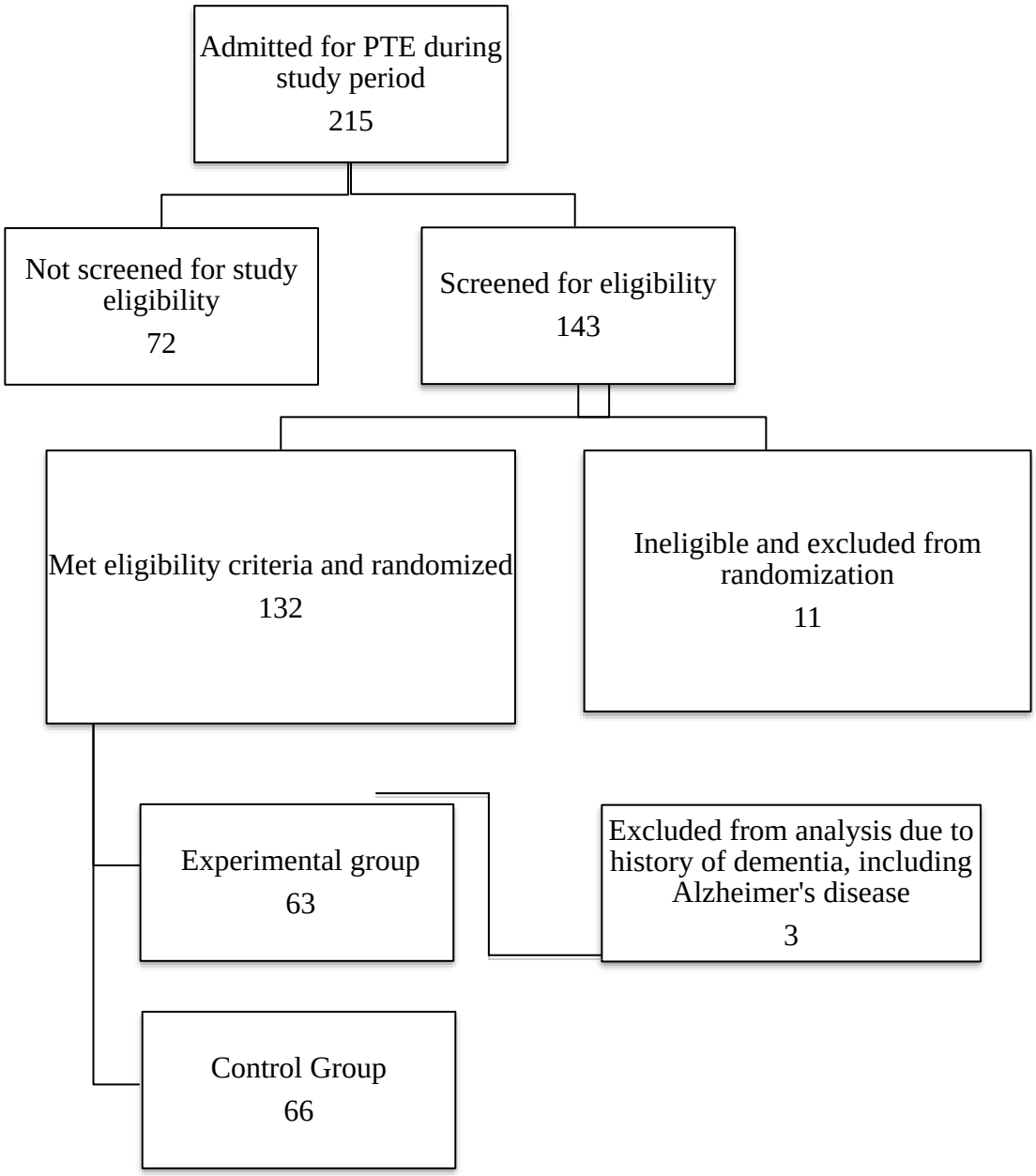


Figure 1 Flow diagram of the study

Table 1 shows demographic characteristics of the experimental and control groups, which were well balanced. The mean age was 54 years old and the majority were female (55.5%) and white (67.4%). About nine percent of the participants reported hearing impairment. Forty-three percent of the participants had other surgical procedures in addition to PTE. Fisher's exact tests showed no significant difference between the experimental and control groups except for support

system presence during the educational session. There were no statistical differences on perioperative characteristics between two groups (total cardiopulmonary time for experimental and control groups were 252 minutes vs 254 minutes) and hemodynamic status. However, the pulmonary artery mean pressure was high for the control group on postoperative day one (20.4 mmHg vs 22.8 mmHg for the experimental and control groups, respectively; p=0.03).

Impacts of multifaceted preoperative patient education

The internal consistency reliabilities of the STAI scales as measured by Cronbach's alphas were 0.94 and 0.91 for the State Anxiety and Trait Anxiety scales, respectively. Table 2 shows the changes in pre- 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 experimental and controls group, but the decreases were not statistically significant between experimental and control groups. However, the knowledge test scores were improved for the experimental group (+1.5) but unchanged for the control group at posttest (0). The differences between the groups were statistically significant (p <0.001). The scores for the patient satisfaction with healthcare providers before ICU discharge were not statistically different for the experimental and control groups. The incidence of delirium was 22.2 % and 31.8% for the experimental and control groups, respectively (p= 0.241). Figure 2 depicts the incidences of delirium over the seven postoperative days.

Table 1 Sample characteristics *(N*=129)

	Total sample *(N*=129)	Experimental (*n*=63)	Control (*n*=66)	*p* value
Age, yr, mean (range)	54 (22-84)	53 (25-84)	55 (22-78)	
Female	71 (55.0)	33 (52.4)	38 (57.6)	
White ethnicity	87 (67.4)	47 (74.6)	40 (60.6)	
Support system presence	121 (93.8)	62 (98.4)	59 (89.4)	0.036
Hearing impairment	11 (8.5)	5 (7.9)	6 (9.1)	
History of alcohol use	49 (38.0)	26 (41.3)	23 (34.8)	
Alcoholism	3 (2.3)	1 (1.6)	2 (3.0)	
Anxiety	19 (14.7)	8 (12.7)	11 (16.7)	
Depression	21 (16.3)	10 (15.9)	11 (16.7)	
PTSD	5 (3.9)	3 (4.8)	2 (3.0)	
Preoperative narcotics use	14 (10.9)	9 (14.3)	5 (7.6)	
Preoperative antianxiety use	13 (10.1)	6 (9.5)	7 (10.6)	
Preoperative psych meds use	14 (10.9)	6 (9.5)	8 (12.1)	
PTE + additional surgical procedures (CABG, Valve, ASD repair & others)	55 (42.6)	28 (44.4)	27 (40.9)	

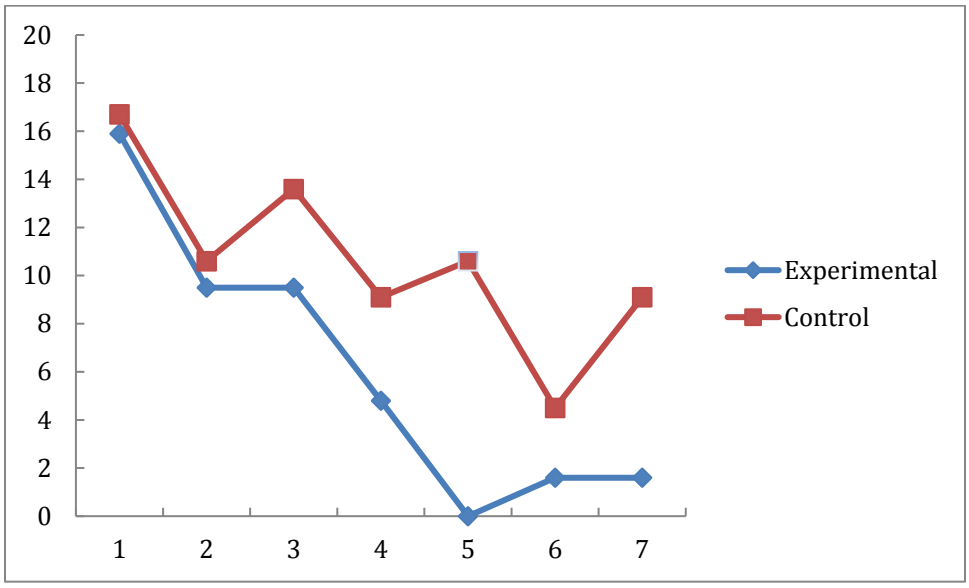
Note. Values are expressed as *n* (%) unless otherwise indicated.
p value by Fisher's exact test.

Table 2 Mean differences in pre- to posttest scores (*N*=129)

	Experimental group	Control group	*p* value[c]
Trait-anxiety[a]	-1.9 (6.6)	-1.8 (3.6)	0.969
State-anxiety [a]	-3.0 (7.0)	-2.1 (7.3)	0.454
Knowledge test[a]	+1.5 (1.7)	0 (0.9)	<0.001
Satisfaction[b] (Range: 4-20)	18.5 (1.9)	18.3 (3.0)	0.581

Note: [a]Mean differences (SD) between pre- and posttest scores
[b]Mean satisfaction scores (SD) prior to discharge
[c] *p*-value by independent *t*-test.

Figure 2 Percent of patients with delirium over the first seven postoperative days



Days of delirium, mechanical ventilation and ICU length of stay

The comparisons of the patient outcome variables between the experimental and control groups are presented in Table 3. The average days of mechanical ventilation were 1.6 days vs 2.4 days for the experimental and control group, respectively (p = 0.038). However, no significant

difference in days of delirium, length of ICU stay, and mortality rate between the groups was found.

Table 3 Comparison of outcome measures

	Total sample (*N*=129)	Experimental (*n*=63)	Control (*n*=66)	*p* value
Days of delirium in ICU mean (SD)	0.6 (1.3)	0.4 (1.1)	0.7 (1.4)	0.159
Days of mechanical ventilation mean (SD)	2.0 (2.3)	1.6 (1.7)	2.4 (2.6)	0.038
Days of ICU length of stay mean (SD)	5.1 (6.9)	4.2 (2.9)	5.9 (9.2)	0.167
In-hospital mortality	2 (1.6)	1 (1.6)	1 (1.5)	

Notes. *p* value by independent *t* test

Predictors for days of delirium, mechanical ventilation and ICU length of stay

The bivariate correlations between the independent variables and three dependent variables (days of delirium, mechanical ventilation, and ICU length of stay) are shown in Table 4. Among the independent demographic and clinical variables, white ethnicity, hearing impairment, support system presence, medical history of anxiety, depression and PTSD, preoperative narcotics use, preoperative psych med use, preoperative PAM, and preoperative PVR had statistically significant correlations with one or more of the dependent variables. In addition, the posttest knowledge score had statistically significant negative correlation with the days of mechanical ventilation (r= - 0.257; p= <0.01), whereas the post-state anxiety and post-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, mechanical ventilation, and ICU length of stay. Since the

preoperative PAM and PVR were collinear, preoperative PVR was not included as a potential predictor in the simultaneous multiple regression models. Model assumptions of normality, linearity, and homoscedasticity were met (Tabachnick & Fidell, 2007).

Table 4 Bivariate correlations

	Days of Delirium	Days of mechanical ventilation	Days of ICU stay
White	0.192*	0.156	-0.038
Hearing impairment	0.252**	0.367**	0.153
Support system presence	-0.109	-0.255*	-0.118
Anxiety	0.014	0.105	0.258**
Depression	0.044	0.026	0.207*
PTSD	0.033	-0.018	0.429**
Preoperative narcotics use	-0.044	-0.045	0.201*
Preoperative PAM	0.159	0.207*	0.304**
Preoperative PVR	0.108	0.061	0.270**
Post-knowledge test score	-0.141	-0.257**	-0.061
Post-state anxiety score	-0.047	-0.061	0.034
Post-trait anxiety score	-0.014	-0.079	-0.043

Note. *$p < 0.05$; ** $p < 0.01$
PTSD; Post-Traumatic Stress Disease; PAM, Pulmonary artery mean pressure; PVR, pulmonary vascular resistance; CPB, cardiopulmonary bypass

The results of the simultaneous multiple regression analyses are shown in Table 5. For the days of delirium as the dependent variable, the potential predictors explained 17.3% of the variance

(R^2= 0.173). Among the predictors, white ethnicity (*beta*=0.21; *p*=0.020), hearing impairment (*beta*=0.24; *p*=0.009), and preoperative PAM (*beta*=0.21; *p*=0.023) reached statistical significance. For the days of mechanical ventilation, the predictor variables explained 30.5% of the variance (R^2=0.305). White ethnicity (*beta*=0.21; *p*=0.014), hearing impairment (*beta*=0.36; *p*<0.001), preoperative PAM (*beta*=0.25; *p*=0.003), and posttest knowledge (*beta*= - 0.20; *p*= 0.018) were the statistically significant predictors for the days of mechanical ventilation. Using the days of the ICU stay as a dependent variable, the potential predictors explained 38.2% of the variance (R^2=0.382). Among predictor variables, hearing impairment (*beta*=0.16; *p*=0.049), preoperative PAM (*beta*=0.25; *p*=0.002), depression (*beta*=0.16; *p*=0.048), and PTSD (*beta*=0.40; *p*<0.001) reached statistical significance.

Table 5 Simultaneous multiple regression models

Predictors	Days of delirium		Days of mechanical ventilation		Days of ICU stay	
	β	*p*	β	*p*	β	*p*
White ethnicity	0.21	0.020*	0.21	0.014*	-0.08	0.298
Hearing impairment	0.24	0.009**	0.36	<0.001***	0.16	0.049*
Preoperative PAM	0.21	0.023*	0.25	0.003**	0.25	0.002**
PTSD	0.04	0.434	-0.01	0.878	0.40	<0.001***
Depression	0.05	0.665	0.03	0.766	0.16	0.048*
Posttest knowledge	-0.11	0.220	-0.20	0.018*	0.02	0.219
	R^2 = 0.173 F Δ $(_{9, 112})$ = 2.606**		R^2 = 0.305 F Δ $(_{9, 112})$ = 5.472***		R^2 = 0.382 F Δ $(_{9, 112})$ = 7.702***	

Note. *p< 0.05; ** p< 0.01; *** p< 0.001
PTSD; Post-Traumatic Stress Disease; PAM, Pulmonary artery mean pressure.

Discussion

In this randomized controlled trial, multifaceted preoperative patient education appeared to improve patients' postoperative care knowledge and mechanical ventilation duration among patients undergoing PTE. In contrast, patient education had no apparent effects on preoperative anxiety, incidence of delirium, or patient satisfaction. In exploratory multivariate analyses, patients' postoperative care knowledge was a significant negative predictor of the mechanical ventilation duration. It was a surprising preliminary finding of the multivariate analyses that hearing impairment was a significant positive predictor of mechanical ventilation duration, ICU stay duration and days of delirium.

This study supports the findings of Johansson, Nuutila, Virtanen, Katajisto, and Salantera (2005), that preoperative education increases knowledge. It is plausible that the knowledge gained through preoperative education allowed the participants to anticipate their surroundings, condition, and enable better adaptation to postoperative stress.

The current study found that the average days of mechanical ventilation were decreased in the experimental group (1.6 days vs 2.4 days), indicating that preoperative education may reduce the length of time spent on a ventilator. The experimental group was taught that they would wake up with a ventilator and endotracheal tube, how it would feel, the sounds it would make, and what to expect from nursing postoperative management. This suggests that knowledge of what to expect postoperatively can accelerate ventilator weaning and extubation. It also highlights the impact that a bedside nurse can have on a patient's post-operative course, and stresses the need to provide individualized education from a nursing prospective.

It is well established that hearing impairment is a risk factor for dementia (Robinson, Rich, Weitzel, Vollmer, & Eden, 2008). Robinson and his colleagues discuss

several studies that have successfully reduced the incidence of dementia with hearing loss protocols that include implementation of adaptive equipment (Robinson, et al., 2008). An unexpected finding of this study, was that hearing impairment is also a statistically significant predictor of days of mechanical ventilation and ICU length of stay. This highlights the importance for ICU nurses to be aware of the factors that contribute to prolonged ventilation, and the importance of nurses prioritizing reestablishment of preoperative sensory baseline. Nursing can help by ensuring that patients have their hearing aide on and working before waking and initiating the weaning process. This simple step is within the realm of the nurse's practice and may lead to improved patient outcomes. In this study, 9% of the participants were hearing impaired. Further research is needed to confirm the effects of hearing impairment in duration of ventilation and the generalizability of these findings to other ICU settings.

This study found that elevated preoperative PAM is a predictor of delirium, length of mechanical ventilation, and ICU length of stay. PAM is an expected contributor to these outcomes as increased pulmonary artery pressures denotes an advanced disease process at baseline. Langer, et al., (2004) found that patients undergoing PTE surgery with high baseline pulmonary pressures had an increased inflammatory response leading to prolonged ICU stay duration. Additionally, severe illness (Robinson, et al., 2008) and inflammatory response (Olson, 2012) are known risk factors of delirium. Previous research also shows a positive correlation between preoperative PVR and decreased lung perfusion (Heinrich et al., 2005), which may lead to prolonged ventilation.

Operative time and pump time were not predictors of delirium - contrary to common ICU belief associated with the term "pump brain." This could be attributed to multiple factors

including advancements in brain perfusion preservation mechanisms, cardiac anesthesia (Jensen et al., 2009), and could be indicative of our center's experience in caring for patients who require this level of care. Further research is needed on the impact of prolonged pump and operative time in this population.

There are multiple surgeries that require mechanical ventilation postoperatively. Many of these patients undergo a similar post-operative course of ICU care and ventilation weaning as the participants in this study. They also are subject to many of the same postoperative complications. Multifaceted education may provide an opportunity for nurses to greatly impact the outcomes of surgical patients. Further research is needed to explore the benefits of education on varied surgical procedures to support the generalizability of this study.

Limitations

The current study has several limitations. First, it was a single-centered study, which may limit generalizability. 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 the PTE surgeries. Second, double blinding of the educational intervention was obviously impractical and the lack of double blinding could have introduced bias. Third, there was a significant difference in support system presence during the educational sessions in the two randomized groups, potentially biasing the results. Fourth, 72 potential patients were not recruited into the study despite attempts to include all patients admitted for PTE during the study period and these patients' demographic data were not collected. This may have resulted in an unrepresentative study population. Fifth, a large number of bedside nurses conducted the daily delirium assessments as opposed to the smaller number of specially trained nurses, whose inter-rater reliability had not been validated. Finally, due to the limited time

between hospital admission and surgery the following morning, the preoperative education and anxiety assessments may have had inadequate time to be assimilated by the participants.

Conclusions

The multifaceted preoperative education appeared to be effective in improving postoperative knowledge and reducing the days of mechanical ventilation among patients undergone PTE. Hearing impairment was an unexpected negative predictor of postoperative delirium, prolonged mechanical ventilation, and ICU length of stay, which may be amenable to nursing intervention. With a better understanding of predictors of postoperative patient outcomes, nurses will be better prepared to identify and provide appropriate care for higher risk patients by working to prevent complications. Further studies are needed to confirm the study findings.

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