Crit Care Nurs Q
Vol. 43, No. 3, pp. 274–285

Nurses' Attitude, Behavior, and Knowledge Regarding Protective Lung Strategies of Mechanically Ventilated Patients

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The management of critically ill patients is complicated and often involves complex devices including mechanical ventilators (MVs), which may be associated with many complications. Protective lung strategies (PLSs) are used to prevent complications associated with MVs, but nurses may not possess adequate knowledge to optimize the efficacy of PLSs. This article reports findings from what is thought to be the first study in Palestine that explores critical care nurses' knowledge about PLSs. The purpose of this study was to assess the critical care nurses' attitude, behavior, and knowledge regarding PLSs of mechanically ventilated patients. This descriptive, cross-sectional study was conducted at both public and private hospitals in Palestine. The sample included nurses who worked in intensive care units and cardiac care units and utilized a previously developed and validated questionnaire. The result of the study concludes that the majority of the Palestinian critical care nurses agree with the utilization or application of PLSs but have a severe lack of knowledge about the strategies. This highlights the need to provide additional educational programs related to the optimum use of mechanical ventilation. **Key words:** *critical care nurses*, *education*, *mechanical ventilation*, *protective lung strategies*

THE FIRST mechanical ventilation was Drinker's ventilator. It was invented in 1928 and known as iron lung.[1] It was used extensively between 1930 and 1950 by patients with polio.[2] The machine used negative pressure to help patient breathe while lying inside an air-tight cylinder. During the 1950s, positive pressure ventilators replaced negative pressure ventilators. Positive pressure ventilation was used during the Second World War to supply oxygen to fighter pilots flying at high altitudes.[1] Positive pressure ventilators are designed to force air into the lungs using a face mask or endotracheal tube. Some authors believe that 80% of intensive care unit (ICU) patients may require mechanical ventilation.[3] It is used when spontaneous breathing is inadequate to maintain oxygenation in cases such as respiratory failure, prolonged postoperative recovery, altered states of consciousness, sepsis, traumatic brain injury, and inability to protect the airway.[4] Although mechanical ventilator (MV) is a vital component of life support, its use may be associated with complications

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The authors have disclosed that they have no significant relationships with, or financial interest in, any commercial companies pertaining to this article.

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DOI: 10.1097/CNQ.0000000000000312

including ventilator-associated pneumonia and acute respiratory distress syndrome (ARDS).[5] Ventilator-associated pneumonia occurs in 10% to 20% of patients on MV in ICUs.[6] In addition, Gajic et al[7] showed that 25% of patients without preexisting lung injury developed acute lung injury (ALI) and 8% of these developed ARDS. Among these patients, 17% experienced these complications within the first 5 days of mechanical ventilation. It is believed that these complications might be a result of the delivery of large tidal volumes and the administration of blood products.[7] The importance of protective lung strategies (PLSs) is substantially increased when patients possess these risk factors.[8] Protective lung strategies include the utilization of low tidal volume (LTV) (6 mL/kg) and moderate to high positive end-expiratory pressure (PEEP) and to maintain a low plateau pressure.[9] These strategies have many benefits including, but not limited to, reducing ventilator-induced lung injury, pulmonary inflammation, and mortality rates in ICU patients.[10] Many studies have demonstrated that PLSs have a beneficial effect in critically ill patients. For example, several randomized clinical trials and meta-analyses have shown that the use of lower tidal volumes and lower pressures in mechanical ventilation may reduce the mortality rate.[10] In addition, Ware and Matthay[11] indicate that the lower tidal volume of 6 mL/kg reduces the mortality rate in patients with ALI and ARDS by 22%, increases the number of ventilator-free days, and reduces the incidence of lung inflammation by reducing plasma interleukin-6 concentrations. High tidal volumes may have a damaging effect on lung tissue by overinflating the alveoli and thereby damaging the normal lung tissues.[9] In addition, Parissopoulos et al[9] recommended keeping plateau pressures less than 30 cm H_2O and in the case of high plateau pressure, the tidal volume should be reduced to 4 mL/kg of ideal body weight. Positive end-expiratory pressure is also an important variable in PLSs, generally recommending the use of higher PEEP to avoid lung collapse. Amato et al[12] also demonstrated a decreased incidence of barotrauma with the use of high PEEP and tidal volumes of 6 mL/kg. In general, the literature recommends the use of PLSs in critically ill patients who are on MV, especially for those who need mechanical ventilation for more than 48 hours.[13]

Caring for patients with MV is an important role for critical care nurses. They play a major role in preventing patients from risk factors, observing early symptoms of complications, and assisting in diagnosis.[14] Critical care nurses need to understand and apply PLSs to reduce the risk of complications associated with MV. It is hypothesized that a lack of knowledge may be a significant barrier for the application of PLSs; therefore, it is important to explore the critical care nurses' knowledge of, as well as their attitude and behavior toward, PLSs. A comprehensive review of the literature showed that this is the first study in Palestine that explores critical care nurses' knowledge of PLSs.

METHODS

A descriptive, cross-sectional study was conducted at specific public and private hospitals in Palestine. Critical care nurses working in ICUs and cardiac care units (CCUs) were included in the study. However, nursing students, nursing in training, and nurses in other departments were excluded from the study. The study was conducted after obtaining approval from the Ministry of Health in Palestine and the Ethical Committee at Birzeit University. A validated questionnaire developed by Dennison et al[15] was used with permission. The questionnaire contains 3 parts: (1) demographic information as shown in Table 1; (2) 21 questions divided into 5 subscales as shown in Table 2; and (3) assessment of nurses' actual knowledge using case studies and multiple-choice questions (MCQs). Data analysis was done using SPSS, version 20. Demographic data were presented as frequencies (n) and percentages (%), while other variables were tested for statistical differences by using the χ^2 test.

Table 1. Demographic Data of Participants

Variables	Frequency (n)	Percentage (%)
Age		
20-25 y	47	42.7
26-38 y	54	49.1
>38 y	9	8.1
Gender		
Male	74	67.3
Female	36	32.7
Level of education		
Diploma degree	23	20.9
Bachelor's degree	82	74.5
Master's degree	5	4.5
Doctoral degree	0	0
Institution		
Public	39	35.5
Private	71	64.5
Working experience in health care		
<6 y	66	60
>6 y	44	40
Ward		
Intensive care unit	68	61.8
Cardiac care unit	42	38.2
Working experience in the current ward		
<6 y	77	70
>6 y	33	30
Number of working hours per week		
<40	26	23.6
40-48	56	59.1
>48	19	17.3
History of previous educational course regarding mechanical ventilator		
Yes	62	56.4
No	48	43.6

Table 2. Questionnaire Subscales

Questionnaire Subscale	Description
Attitude subscale	9 questions
Behavior subscale	3 questions
Knowledge Self-rating subscale	2 questions
Nurse's Actual Knowledge subscale	4 questions
ICU or Organizational Barriers subscale	3 questions

Abbreviation: ICU, intensive care unit.

RESULTS

The questionnaires were provided to 137 nurses, with 110 responses received. The response rate was almost 80%. Most of the participants were between 20 and 25 years of age (42.7%), and almost 8% were older than 38 years. More than two-thirds of the participants were males (67.3%), and the vast majority of them had a bachelor's degree in nursing (74.5%). In addition, almost two-thirds of the participants worked in the private sector (64.5%). In addition, the majority of participants had work experience of less than 6 years (60%) as nurses and 70% of them reported work experience of the same period in the current ward. More than half (61.8%) of participants worked in ICUs and 59.1% worked between 40 and 48 hours per week. However, a surprising proportion of the participants claimed not receiving any specialized training or educational workshops on mechanical ventilation (43.6%).

Participants' attitudes toward the application of PLSs were assessed by asking 9 questions. One of those questions was about care provided by respiratory therapists, a specialty that does not exist in Palestine yet (question 9). Therefore, this question in addition to question 21 was not used in our analysis. The vast majority of participants tended to agree with the utilization or application of PLSs as shown in Figure 1. Similar results were noticed in answers of questions about the participants' actual practices (questions 11-13). The majority reported to apply and recommend the application of lung protective ventilation to others as shown in Figure 2.

Similarly, the majority of participants rated themselves as knowledgeable in lung protective ventilation based on self-rating questions (questions 14 and 15) as shown in Figure 3. In addition, the majority of participants tended to agree with questions asked about ICU or organizational barriers (questions 19 and 20) as shown in Figure 4.

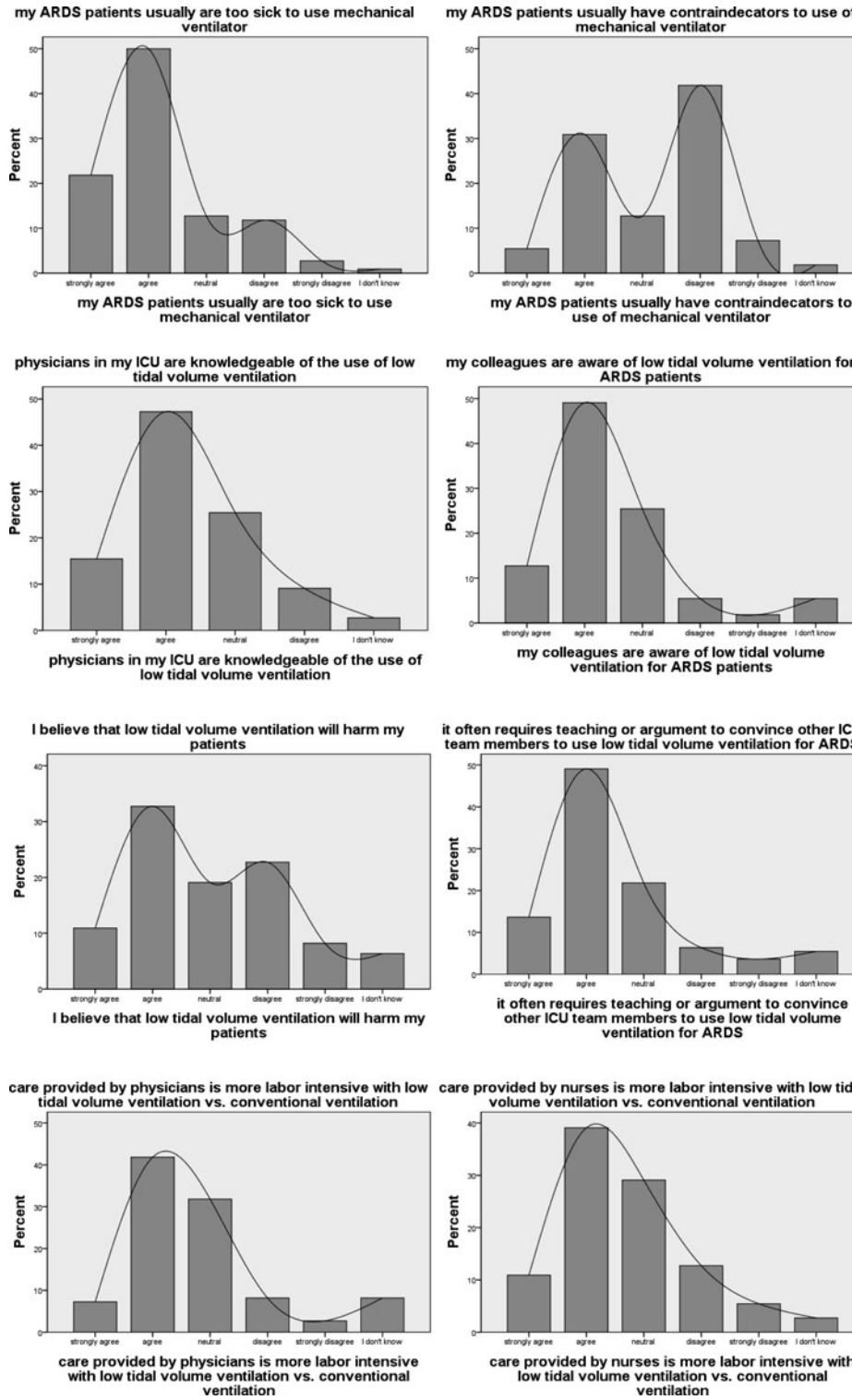

Figure 1. The participants' attitude toward the application and utilization of protective lung strategies. ARDS indicates acute respiratory distress syndrome; ICU, intensive care unit.

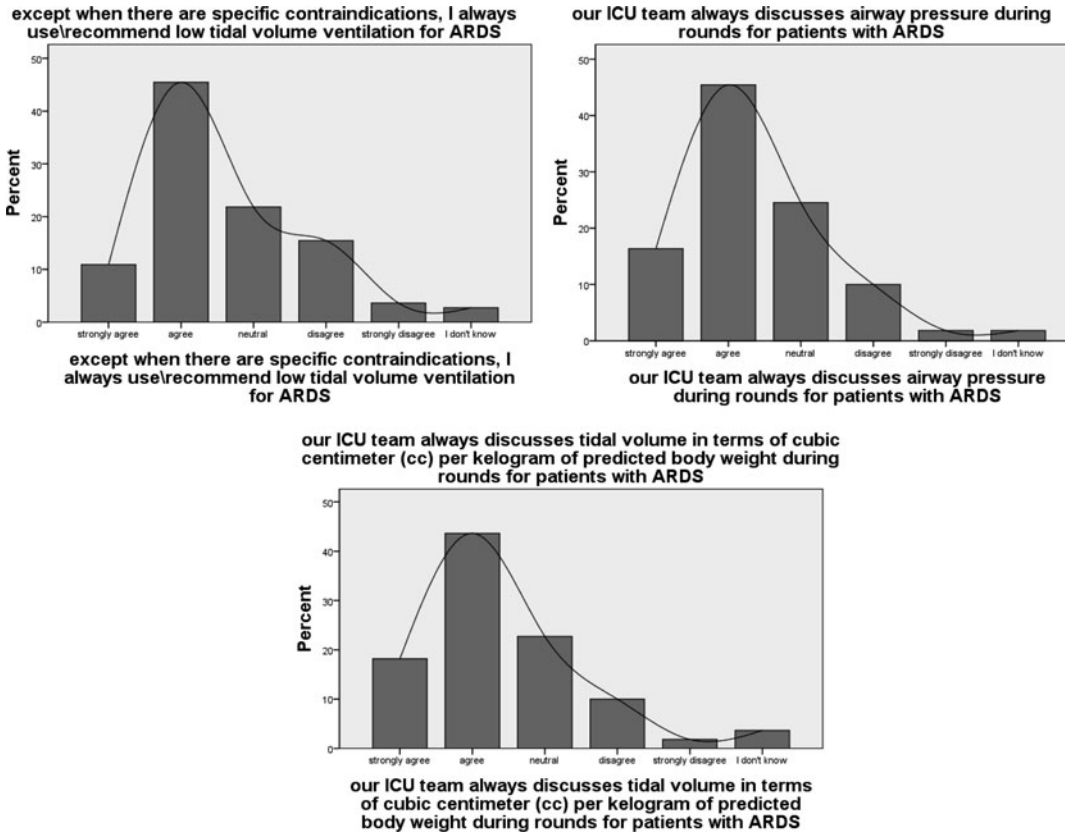

Figure 2. Questions related to clinical practice. ARDS indicates acute respiratory distress syndrome; ICU, intensive care unit.

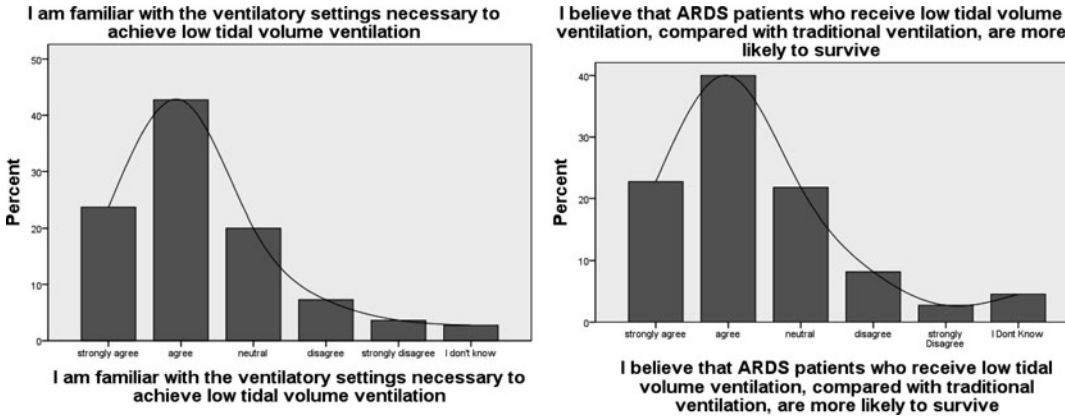

Figure 3. Knowledge self-rating questions. ARDS indicates acute respiratory distress syndrome.

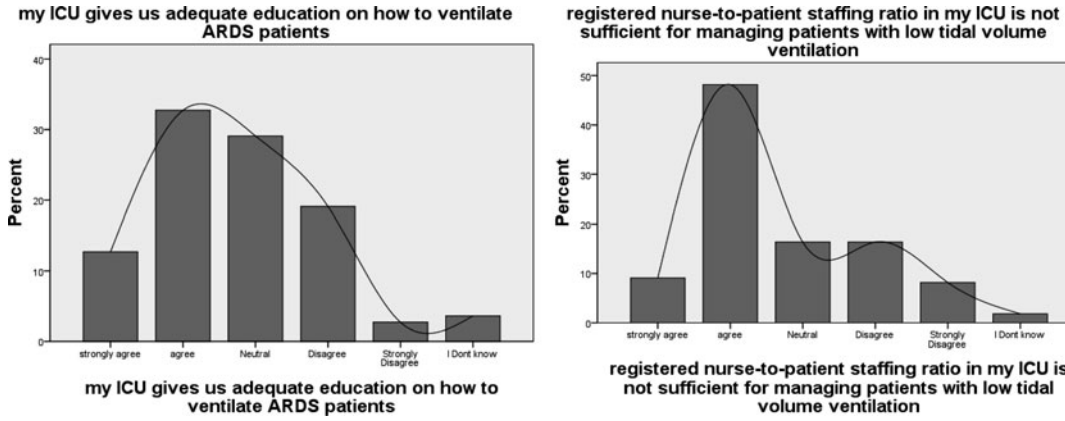

Figure 4. ICU or organizational barriers. ARDS indicates acute respiratory distress syndrome; ICU, intensive care unit.

An additional 8 questions were asked to test the participants' actual knowledge. Four questions were in the form of a Likert scale (questions 10, 16, 17, and 18) and 4 questions in the form of MCQs based on case studies, with only one correct answer (questions 22, 23, 24, and 25). Unexpectedly, the majority of participants chose to agree with the statements of the Likert scale questions while they would disagree if they were truly knowledgeable (Figure 5). The results of MCQs were in line with the previous result where only 13 participants (11.8%) were able to answer half or more of the questions correctly (Figure 6).

A χ^2 test was conducted to detect any statistical difference in the answers of the participants based on their demographics, where participants were grouped by their age (whether older or younger than 25 years), gender, level of education, type of institution, previous courses in mechanical ventilation, work experience in health care, and work experience in the current ICU. Table 3 shows data related to attitudes of nurses toward the application of lung protective strategies. During data analysis, the answers of the Likert scale were maintained. In Table 3, similar answers were pooled in the calculation of percentages of agree and strongly agree, as well as disagree and strongly disagree.

The main difference in attitude based on gender was in the nurses' opinion whether the physician's care is more labored toward the application of LTV ventilation as a lung protective strategy versus conventional ventilation. A greater proportion of females tended to disagree (19.4% vs 6.7%, $P = .02$), while a greater proportion of males tended to be neutral on this question. In addition, a larger proportion of nurses who worked in the private sector believed that their physicians are knowledgeable about the application of LTV (66.1% vs 56.4, $P = .005$), while a greater proportion (43.5% vs 19.7%) of the nurses who worked in the public sector tended to be neutral. Moreover, nurses' attitudes varied the most when the participants were grouped on the basis of whether they had specialized educational or training courses in mechanical ventilation. Surprisingly, a greater proportion of those who reported to have previous educational or training courses specialized in mechanical ventilation tended to agree with the statement that states that LTV will harm the patients (45.1% vs 41.6%, $P = .002$) while 32.2% were neutral (vs 16.6%). In addition, a greater proportion of the same group tended to agree when they were asked whether it often requires teaching or persuasive debates to convince other ICU team members to use LTV ventilation for ARDS patients (69.3% vs

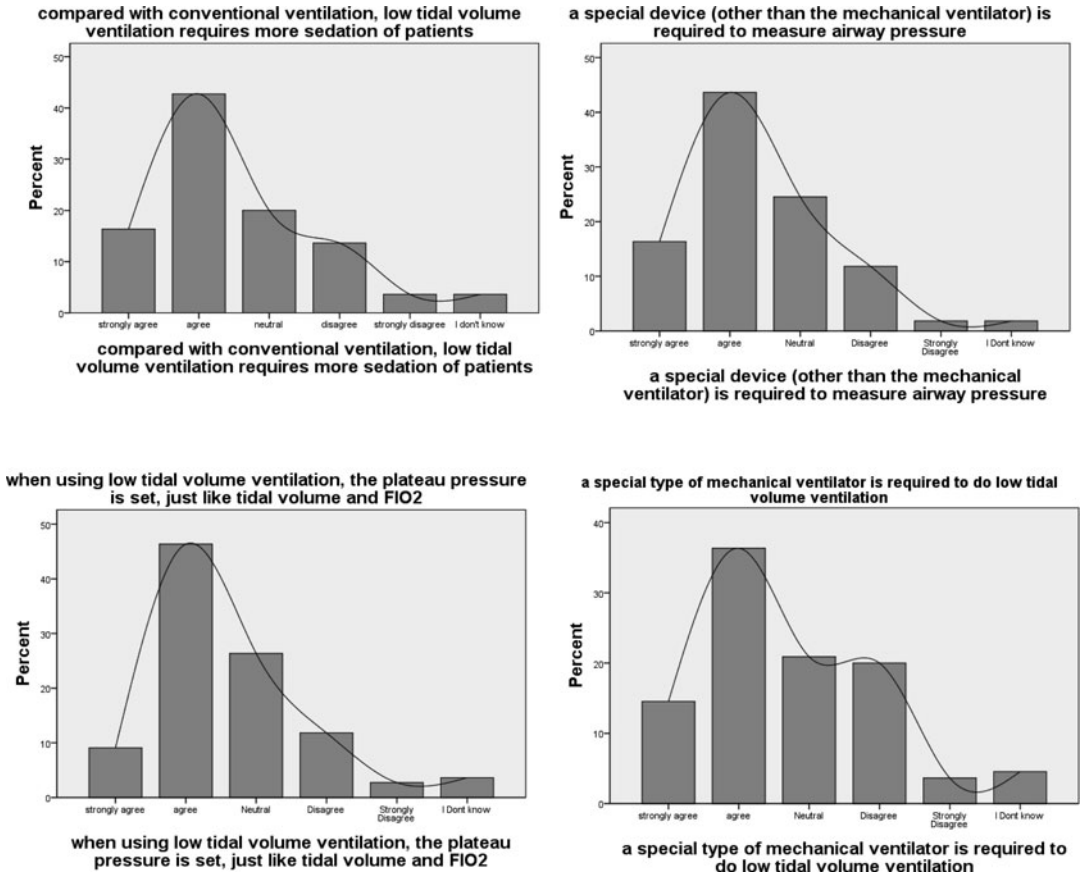

Figure 5. Knowledge testing questions. FIO_2 indicates fraction of inspired oxygen.

54.1%, $P = .01$). It was noted that a greater proportion of the same group tended to agree (56.4% vs 39.5%, $P = .006$) when asked about their opinion about whether the physician's care is more labored toward the application of LTV ventilation as a lung protective strategy than conventional ventilation.

The results demonstrated that a greater proportion of nurses who worked in a medical/surgical ICU tended to disagree with the statement that LTV will harm the patients (38.2% vs 19%, $P = .027$) while 40.4% of those who worked in the CCU tended to be neutral. When participants were grouped on the basis of their work experience, it was revealed that those with experience of less than 6 years tended to think that their physicians are knowledgeable about the application of LTV as a lung protective strategy (68.2% vs 54.5%, $P = .031$). (See Tables 4 and 5 for data related to the variation in actual practices of nurses based on their demographics and variation in nurses' knowledge based on their demographics, respectively.)

DISCUSSION

This study was conducted in the 8 largest hospitals (5 private and 3 public hospitals) that are located in the 3 largest governorates in Palestine, where almost 49.5% of the West Bank Palestinian population is located according to the Palestinian Central Bureau of Statistics (2017).

Data analysis showed that the vast majority of the participants tend to agree with

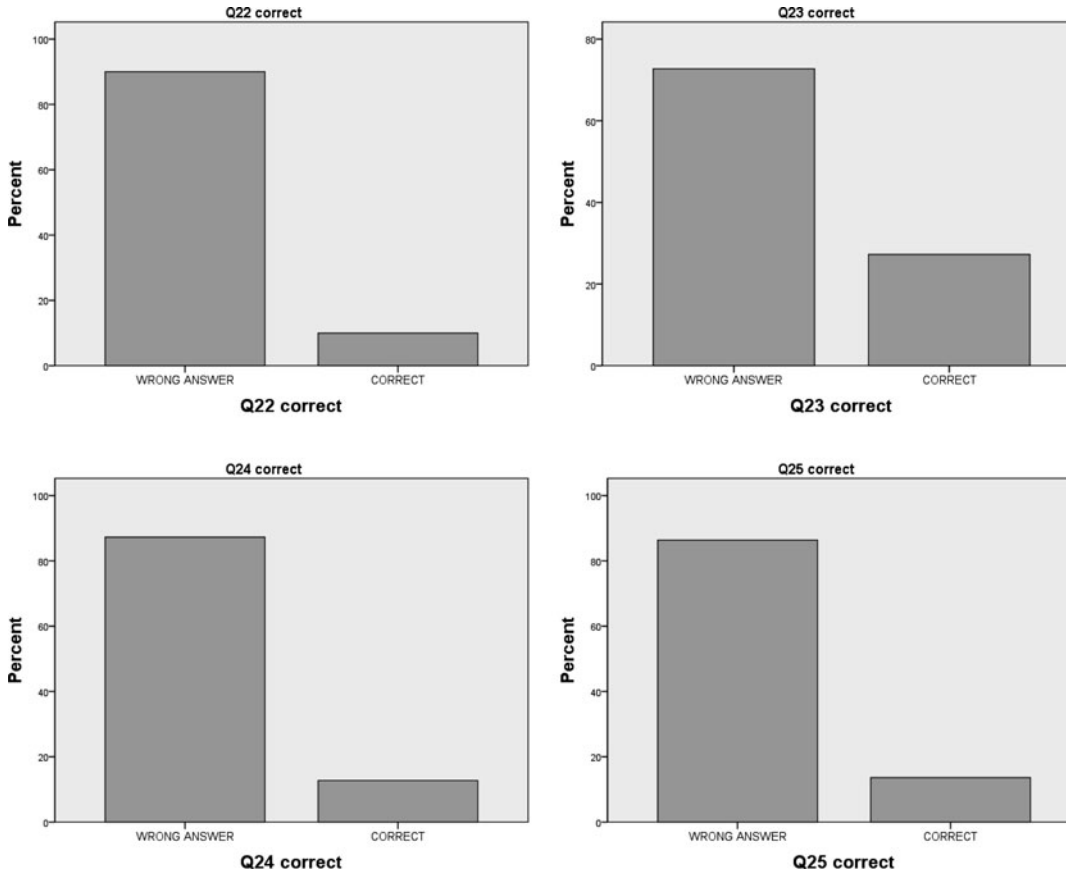

Figure 6. Multiple-choice questions.

the utilization or application of lung protective strategies as shown in Figure 1. Similar results were noticed in answers of questions about the participants' actual practices where the majority reported to apply and recommend the application of lung protective ventilation to others as shown in Figure 2. Moreover, the majority of participants rated themselves as knowledgeable in lung protective ventilation based on self-rating questions. These promising results unfortunately did not come in line with the results of the questions that assess the nurses' actual knowledge about PLSs. Researchers noted that the majority of participants chose to agree with the statements of the Likert scale questions while they would disagree if they were truly knowledgeable (Figure 4). Similarly, the results of the MCQs showed that only 13 (11.8%) participants were able to answer half or more of the questions correctly. These results highlight an urgent need for more specialized training and educational programs to empower Palestinian critical care nurses who care for patients on mechanical ventilation. In addition, these results may suggest that the Palestinian academic institutions should develop academic programs specialized in respiratory therapy in order to compensate for this shortage. These recommendations are supported by the data derived from the analysis of the Knowledge subscale when participants were grouped on the basis of whether they received educational or training courses specialized in mechanical ventilation. A statistically significant proportion of those who

Table 3. Nurses' Attitude Toward the Application of Lung Protective Strategies

Grouping Variable	Items	Total Number in Group	% Tend to Agree	% Tend to Disagree	% Neutral	*P*
Gender						
Male	Care provided by physicians is more labor intensive with low tidal volume ventilation vs conventional ventilation	74	47.2	6.7	45.9	.02
Female		36	52.7	19.4	27.7	
Type of institution						
Public	Physicians in my ICU are knowledgeable on the use of low tidal volume ventilation	71	66.1	16.9	19.7	.005
Private		39	56.4	0	43.5	
Previous courses in mechanical ventilation						
Yes	I believe that low tidal volume ventilation will harm my patients	62	45.1	22.5	32.2	.002
No		48	41.6	41.6	16.6	
Yes	It often requires teaching or argument to convince other ICU team members to use low tidal volume ventilation for ARDS	62	69.3	6.4	24.1	.01
No		48	54.1	14.5	31.2	
Yes	Care provided by physicians is more labor intensive with low tidal volume ventilation vs conventional ventilation	62	56.4	9.6	33.8	.006
No		48	39.5	12.5	47.9	
Type of intensive care unit (medical/surgical ICU and CCU)						
ICU	I believe that low tidal volume ventilation will harm my patients	68	45.5	38.2	16.1	.027
CCU		42	40.4	19	40.4	
Work experience in health care						
<6 y	Physicians in my ICU are knowledgeable on the use of low tidal volume ventilation	66	68.2	10.6	21.2	.031
>6 y		44	54.5	6.8	38.7	

Abbreviations: ARDS, acute respiratory distress syndrome; CCU, critical care unit; ICU, intensive care unit.

had training courses on mechanical ventilation were likely to choose the appropriate answer. However, many of the participants still have knowledge deficiencies, which raise questions on the content of the courses they received, as well as how frequently they attended such courses.

Considering that 88.2% of the study participants were found to have a severe lack of knowledge about PLSs, analysis of the

Table 4. Variation in Actual Practices of Nurses Based on Their Demographics

Grouping Variable	Items	Total Number in Group	% Tend to Agree	% Tend to Disagree	% Neutral	*P*
Age						
<25 y	Our ICU team always discusses airway pressure during rounds for patients with ARDS	47	53.2	10.6	36.1	.04
>25 y		63	68.2	12.6	19	
Gender						
Male	Our ICU team always discusses tidal volume in terms of cubic centimeter (cc) per kilogram of predicted body weight during rounds for patients with ARDS	74	64.9	9.5	25.7	.039
Female		36	55.5	16.7	27.8	
Previous courses in mechanical ventilation						
Yes	Except when there are specific contraindications, I always use\recommend low tidal volume ventilation for ARDS	62	62.9	11.3	25.8	.026
No		48	47.9	29.1	22.9	
Yes	Our ICU team always discusses airway pressure during rounds for patients with ARDS	62	66.2	3.2	30.6	.011
No		48	56.2	23	20.8	
Type of intensive care unit (medical/surgical ICU and CCU)						
ICU	Except when there are specific contraindications, I always use\recommend low tidal volume ventilation for ARDS	68	55.9	26.5	17.6	.012
CCU		42	57.2	7.1	35.7	

Abbreviations: ARDS, acute respiratory distress syndrome; CCU, critical care unit; ICU, intensive care unit.

results of the questionnaire subscales (nurses' attitudes, behavior/practices, and knowledge self-rating questions) should be interpreted with caution. This means that the vast majority of participants tend to agree with the application of PLSs. Nevertheless, the proper application of these strategies cannot be ensured because of the lack of knowledge on how to apply these techniques at the bedside. Moreover, the fact that the majority of participants reported that their institutions provide them with adequate training programs on mechanical ventilation, and that the majority of them rated themselves as knowledgeable about PLSs, suggests that the nurses did not have a chance to educate themselves about the latest updates in the literature on this topic.

CONCLUSIONS

The findings indicated that critical care nurses in Palestine have a low level of knowledge about PLSs. Nurses in critical care units need to possess valid knowledge to be able to provide optimal nursing care.[16] The results

Table 5. Variation in Nurses' Knowledge Based on Their Demographics

Grouping Variable	Items	Total Number in Group	% Tend to Agree	% Tend to Disagree	% Neutral	*P*
Gender						
Male	I am familiar with the ventilator settings necessary to achieve low tidal volume ventilation	74	71.6	5.4	23	.027
Female		36	55.5	22.2	22.3	
Previous courses in mechanical ventilation						
Yes	I believe that ARDS patients who receive low tidal volume ventilation, compared with traditional ventilation, are more likely to survive	62	72.6	3.2	24.2	.038
No		48	50	20.9	29.1	
Yes	When using low tidal volume ventilation, the plateau pressure is set, just like tidal volume and FIO_2	62	67.8	8	24.2	.001
No		48	39.6	22.9	37.4	
Yes	A special type of mechanical ventilator is required to do low tidal volume ventilation	62	58	11.3	30.7	.008
No		48	41.6	39.5	18.8	
Yes	My ICU gives us adequate education on how to ventilate ARDS patients	62	59.7	9.7	30.6	.002
No		48	27	37.5	35.4	

Abbreviations: ARDS, acute respiratory distress syndrome; CCU, critical care unit; FIO_2, fraction of inspired oxygen; ICU, intensive care unit.

identify the importance of educational programs regarding mechanical ventilation and PLSs, which should include case study analyses, tests, and training videos. The critical care nurses need more educational courses and practice about invasive mechanical ventilation indications, types of ventilator, modes of ventilation, ventilator settings, and weaning processes. The patient with ARDS should be administered oxygen at the lowest level possible to improve tissue oxygenation with PEEP, thus reducing FIO_2 (fraction of inspired oxygen) to less toxic levels.[17] Barotrauma is an alveolar injury or rupture occurs as a result of excessive pressure and volume that lead to tension pneumothorax.[18] In Palestine, there is a shortage of respiratory therapists who take care of patients with MV and in some hospitals they are unavailable, which lead the critical care nurses to take the responsibility for the care of patients with MV. Mechanical ventilation with high levels of PEEP, high tidal volumes, and volume-controlled modes predisposes the patient with ARDS to volutrauma.[19] Critical care nurses must have skills and knowledge to take care of patient with MV, optimizing oxygenation and ventilation, providing comfort and emotional support, and preventing all complications regarding using ventilators.

REFERENCES

1. Slutsky AS. History of mechanical ventilation. From Vesalius to ventilator-induced lung injury. *Am J Respir Crit Care Med*. 2015;191(10):1106-1115.
2. Hasan A. *Understanding Mechanical Ventilation: A Practical Handbook*. New York, NY: Springer Science & Business Media; 2010.
3. Hesham S. Assessment of nurses' performance regarding management of patients on mechanical ventilator. *Port Said Sci J Nurs.* 2016;3(1):161-177.
4. Guilhermino MC, Inder KJ, Sundin D., Education on invasive mechanical ventilation involving intensive care nurses: a systematic review. *Nurs Crit Care*. 2018;23(5):245-255.
5. Rose L. Clinical application of ventilator modes: ventilatory strategies for lung protection. *Aust Crit Care*. 2010;23(2):71-80.
6. Hellyer TP, Ewan V, Wilson P, Simpson AJ. The Intensive Care Society recommended bundle of interventions for the prevention of ventilator-associated pneumonia. *J Intensive Care Soc.* 2016;17(3):238-243.
7. Gajic O, Dara SI, Mendez JL, et al. Ventilator-associated lung injury in patients without acute lung injury at the onset of mechanical ventilation. *Crit Care Med*. 2004;32(9):1817-1824.
8. Cornish S, Wynne R, Klim S, Kelly AM. Protective lung strategies: a cross sectional survey of nurses knowledge and use in the emergency department. *Australas Emerg Nurs J.* 2017;20(2):87-91.
9. Parissopoulos S, Mpouzika MD, Timmins F. Optimal support techniques when providing mechanical ventilation to patients with acute respiratory distress syndrome. *Nurs Crit Care*. 2017;22(1):40-51.
10. Needham DM, Colantuoni E, Mendez-Tellez PA, et al. Lung protective mechanical ventilation and two year survival in patients with acute lung injury: prospective cohort study. *BMJ*. 2012;344:e2124.
11. Ware LB, Matthay MA. The acute respiratory distress syndrome. *N Engl J Med.* 2000;342(18):1334-1349.
12. Amato MB, Barbas CS, Medeiros DM, et al. Effect of a protective-ventilation strategy on mortality in the acute respiratory distress syndrome. *N Engl J Med.* 1998;338(6):347-354.
13. Joynes E, Dalay S, Patel JM, Fayek S. A complete audit cycle to assess adherence to a lung protective ventilation strategy. *Indian J Crit Care Med.* 2014;18(11):746.
14. Zeb A, Hasnain M, Ahmad I, Khan S, Ali Shah A. Nurses' knowledge regarding prevention of ventilator associated pneumonia. *LOJ Nurs Healthc*. 2018;2(1). doi:10.32474/LOJNHC.2018.02.000129.
15. Dennison CR, Mendez-Tellez PA, Wang W, Pronovost PJ, Needham DM. Barriers to low tidal volume ventilation in acute respiratory distress syndrome: survey development, validation, and results. *Crit Care Med*. 2007;35(12):2747-2754.
16. Devlin JW, Fong JJ, Howard EP, et al. Assessment of delirium in the intensive care unit: nursing practices and perceptions. *Am J Crit Care*. 2008;17(6):555-565.
17. Urden LD, Stacy KM, Lough ME. *Critical Care Nursing-E-Book: Diagnosis and Management*. St Louis, MO: Elsevier Health Sciences; 2017.
18. Sole ML, et al. *Introduction to Critical Care Nursing*. 5th ed. St Louis, MO: Saunders, 2009:xix.
19. Morton PG, et al. *Critical Care Nursing: A Holistic Approach*. Vol 1. Philadelphia, PA: Lippincott Williams & Wilkins; 2005.