# Nursing Care of an Elderly Patient with Postoperative Lung Injury Following Purulent Cholecystitis Surgery Undergoing Modified Prone Position Ventilation: A Case Report (Postprint)

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## Abstract

This article summarizes the nursing experience of an elderly patient with purulent cholecystitis who, after surgery and endotracheal intubation, experienced difficulty weaning from invasive ventilation due to combined lung injury but successfully discontinued invasive ventilation following implementation of modified prone position ventilation. The effects of prone position ventilation in the treatment and nursing care of elderly patients with purulent cholecystitis complicated by lung injury after surgery ensure patient safety before and after prone positioning, prevent complications, and promote recovery. Through close monitoring of vital signs, management of sedation and analgesia, comprehensive management throughout the implementation of modified prone position ventilation, nursing care for shallow suctioning during prone position suctioning, prevention of pressure injuries, prevention of catheter blockage and tube dislodgement, and psychological nursing for patients and their families, early weaning from invasive ventilation can be facilitated for elderly patients with purulent cholecystitis complicated by lung injury after surgery. After meticulous treatment and nursing care, this case of modified prone position ventilation implementation resulted in successful discontinuation of ventilatory support. On postoperative day 10, the patient received Venturi oxygen therapy at 40% oxygen concentration and 8 L/min flow rate, with oxygen saturation of 100%, clear consciousness, stable condition, and was transferred to the surgical ward for continued treatment, achieving good recovery outcomes.

## Full Text

## Preamble

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# Nursing Care for a Postoperative Elderly Patient with Purulent Cholecystitis Complicated by Lung Injury Undergoing Modified Prone Position Ventilation

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### Abstract

This article summarizes the nursing experience of a postoperative elderly patient with purulent cholecystitis who had difficulty weaning from invasive mechanical ventilation after developing lung injury, but successfully discontinued ventilation after implementing modified prone position ventilation. We describe the therapeutic and nursing effects of prone position ventilation in elderly postoperative purulent cholecystitis patients with lung injury, ensuring patient safety before and after prone positioning and preventing complications to promote recovery. Through meticulous monitoring of vital signs, management of sedation and analgesia, comprehensive management of the modified prone position implementation process, shallow suctioning during prone position ventilation, prevention of pressure injuries, prevention of catheter obstruction and dislodgement, and psychological care for both patient and family, we facilitated successful weaning from invasive mechanical ventilation. After intensive treatment and nursing care, the patient successfully discontinued ventilatory support. On postoperative day 10, the patient received Venturi oxygen therapy at 40% $FiO_2$ and 8 L/min flow rate, maintaining 100% oxygen saturation with clear consciousness. The patient was transferred to the surgical ward in stable condition with good recovery outcomes.

**Keywords:** elderly; purulent cholecystitis; modified prone position; nursing care

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## Introduction

Acute purulent cholecystitis in elderly patients is a critical biliary tract infection commonly encountered in clinical practice, caused by bacterial invasion or cystic duct obstruction leading to acute gallbladder inflammation [1]. Clinical manifestations typically include paroxysmal colicky pain in the right upper quadrant, with notable tenderness and muscle rigidity upon palpation [2]. As physiological functions of various organs gradually decline in elderly patients, their stress response capacity and immune function decrease. Combined with severe and rapidly progressing disease, these patients are prone to gallbladder perforation and septic shock, which increase surgical risks. Postoperative complications are numerous and severe, with acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) being particularly serious complications during the perioperative period of abdominal surgery in elderly patients. ALI/ARDS represents a rapid and continuous pathophysiological process with acute onset and rapid progression, closely related to various inflammatory responses in the body. It often triggers systemic inflammatory response syndrome and multiple organ failure, with mortality rates exceeding 40% in moderate to severe cases [3], and can even lead to death [4].

Prone Position Ventilation (PPV) refers to a therapeutic positioning nursing intervention that assists patients into the prone position during mechanical ventilation to improve oxygenation [5]. For elderly patients with acute cholecystitis complicated by lung injury requiring invasive mechanical ventilation, prone position ventilation therapy and nursing care involve effective assessment, standardized implementation protocols, and rigorous process control to reduce related complications and improve prognosis [5]. This approach provides nursing staff with evidence-based, standardized procedures to manage each aspect of prone position implementation, ensuring safe and effective ventilation for elderly postoperative acute cholecystitis patients. In January 2022, our hospital admitted an elderly patient with acute purulent cholecystitis. Through meticulous team-based treatment and nursing care, the patient was transferred back to the surgical ward on postoperative day 10 for continued treatment.

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## 1. Clinical Data

### 1.1 General Information

The patient was an 87-year-old male admitted through the fever clinic with "decreased appetite and fever for 3 days, worsening with abdominal pain and altered consciousness for 1 day." He had a history of hypertension for over 10 years, treated intermittently with nifedipine. Three days prior, after consuming persimmons, he developed decreased appetite and a maximum home-measured temperature of 37.6°C, accompanied by acid reflux and heartburn. His appetite loss was significant, with fixed dull pain in the right upper quadrant. He vomited twice, producing approximately 5 ml of green bitter fluid, accompanied by acid

reflux, heartburn, and fever.

Admission vital signs: temperature 36.8°C, heart rate 122 beats/min with absolutely irregular rhythm, respiratory rate 16 breaths/min, blood pressure 143/92 mmHg, oxygen saturation 100%. Glasgow Coma Scale score was E3V5M6 (13 points). Pupils were equal and round at 2 mm, with sluggish light reflex. Abdominal examination revealed epigastric tenderness without rebound tenderness, no palpable masses, positive Murphy' s sign, and tympanic percussion. Laboratory findings: white blood cells 29.54 × $10^9$/L (reference 4–10 × $10^9$/L), neutrophils 93.2% (50%–70%), C-reactive protein 294.08 mg/L (0–10 mg/L), procalcitonin 11.380 ng/ml (0–0.5 ng/mL). Arterial blood gas (on 3 L/min nasal cannula): $PaO_2$ 69.7 mmHg, $PaCO_2$ 33.9 mmHg, $HCO_3^-$ 21.6 mmol/L, BE -3.80 mmol/L, $SO_2$ 94.9%, $Ca^{2+}$ 1.110 mmol/L, $K^+$ 4.0 mmol/L, lactate 1.8 mmol/L. Bedside hepatobiliary ultrasound showed thickened gallbladder wall, gallbladder stasis with stones, and pericholecystic fluid. Upper abdominal CT suggested acute purulent cholecystitis.

### 1.2 Treatment and Outcome

After admission, the patient underwent comprehensive evaluation and preoperative preparation, followed by emergency laparoscopic cholecystectomy under general anesthesia. Postoperative management included invasive mechanical ventilation, aggressive fluid resuscitation, anti-inflammatory and anti-infective therapy, fasting and fluid restriction, gastrointestinal decompression, acid suppression and gastric protection, parenteral nutrition support, and traditional Chinese medicine treatment to replenish qi, nourish yin, clear heat, and resolve dampness. On postoperative day 5, despite treatment with Tienam (imipenem/cilastatin) combined with Vancomycin for infection and methylprednisolone for inflammation, the patient remained dependent on invasive mechanical ventilation and experienced difficult weaning. Arterial blood gas showed: pH 7.501, $PaO_2$ 73.2 mmHg, $PaCO_2$ 35.4 mmHg, $K^+$ 3.7 mmol/L, lactate 0.9 mmol/L; ventilator $FiO_2$ 40%, oxygenation index 197.25 mmHg. Repeat chest CT revealed bilateral pleural effusion with atelectasis of both lower lobes, indicating secondary lung injury following septic shock.

On postoperative day 6, prone position ventilation was initiated for 1 hour. The patient remained hemodynamically stable with good tolerance. Manual percussion and mechanical vibration were used to promote sputum evacuation and effectively clear airway secretions. Repeat arterial blood gas showed: pH 7.460, $PaO_2$ 147 mmHg, $PaCO_2$ 42.6 mmHg, $K^+$ 3.8 mmol/L, lactate 1.0 mmol/L; ventilator $FiO_2$ 35%, oxygenation index 420 mmHg. On postoperative day 7, the patient was successfully weaned from mechanical ventilation and extubated, with stable vital signs, and transitioned to non-invasive ventilatory support. On postoperative day 10, the patient received Venturi oxygen therapy at 40% $FiO_2$ and 8 L/min flow, maintaining 100% oxygen saturation with clear consciousness. The patient was transferred back to the surgical ward in stable condition.

## 2. Nursing Care

### 2.1 Close Monitoring of Vital Signs and Sedation-Analgesia Management

Prone position ventilation alters cardiac position, hemodynamics, and intrathoracic pressure due to changes in patient positioning. These changes can make observation and manipulation challenging for nursing staff. Before prone position ventilation, we closely monitored and recorded all parameters to establish baseline reference values. During prone position ventilation, continuous cardiac monitoring was maintained while observing changes in respiration, facial color, consciousness, and blood pressure, with prompt intervention for any abnormalities. Positional changes may cause cardiac displacement and alter pressure values from hemodynamic monitoring; therefore, recalibration was performed for patients with hemodynamic monitoring to ensure data validity and accuracy. Continuous bedside monitoring by nursing staff prevented sudden changes in vital signs or position.

During prone position ventilation in this patient, we positioned ECG leads in a mirror-image relationship to their placement in supine position. Sedation and analgesia were achieved using combined propofol, midazolam, and fentanyl citrate. Nurses assessed pain scores every 4 hours and Richmond Agitation-Sedation Scale (RASS) scores hourly, adjusting medication dosages based on scores to maintain RASS at -4 to -5 (responsive to physical stimuli only or unresponsive to both voice and physical stimuli) [6].

### 2.2 Pre-Implementation Assessment for Modified Prone Position

#### 2.2.1 Patient Assessment Before Prone Positioning

1. **Hemodynamics:** Vital signs should be relatively stable to tolerate prone position ventilation.
2. **Sedation Status:** Deep sedation is recommended for mechanically ventilated patients during prone position ventilation, with RASS scores of -4 to -5 [6].
3. **Artificial Airway:** Confirm endotracheal or tracheostomy tube position and clear airway and oral/nasal secretions.
4. **Gastrointestinal Tract:** Suspend enteral nutrition 2 hours before prone position ventilation and aspirate gastric contents to avoid regurgitation and aspiration from excessive residual volume.
5. **Other:** Check all catheters for proper placement and patency, confirm whether they can be temporarily clamped, inspect local dressings for needed changes, and assess skin condition in pressure-prone areas.

**2.2.2 Healthcare Team Assessment Before Prone Positioning** Select a professional medical team with training and extensive clinical experience to implement prone position ventilation [7-9], with clear division of labor to ensure safety of managed areas and tubing.

**2.2.3 Equipment Preparation** Prepare ECG electrodes, foam dressings, nursing pads, cotton pads, clean bed sheets, three silicone soft pillows (water pillows or soft pillows), one horseshoe-shaped pillow (U-shaped pillow), warming equipment. All patient-connected tubing should be promptly clamped or opened as needed, with critical lines secured using dual fixation [10].

**2.2.4 Modified Prone Position Ventilation Implementation Protocol** With assistance from 2-3 nurses, the patient is first moved to one side of the bed, then turned toward the opposite side into a lateral position. The buttocks are shifted backward, the upper leg is flexed forward, the lower shoulder is moved backward, and the upper arm is naturally bent and secured to the opposite bed rail. The upper arm and shoulder are shifted slightly forward. Soft pillows are placed at the shoulders, hips, knees, and ankles to prevent excessive pressure. The patient' s chest is maintained at approximately a 60° angle to the bed, with soft pillows placed under the chest and abdomen while avoiding surgical wounds. The head is turned to one side and secured with a head ring, with the head of bed elevated 15-20° to reduce facial edema. All catheters and leads are properly secured [11].

### 2.3 Suctioning Method During Prone Position Ventilation

During mechanical ventilation, the use of sedative-analgesic agents or muscle relaxants, suppressed cough reflex, and retained secretions in bronchioles and airways can lead to accumulation of large amounts of viscous secretions in deep bronchi [12]. On January 19 (one month postoperatively), CT re-examination revealed bilateral pleural effusion with atelectasis of both lower lobes. During prone position ventilation, we combined mechanical vibration therapy for pulmonary care. Given the bilateral pleural effusion and lower lobe atelectasis, vibration therapy targeted the bilateral lower lung fields. Nebulization therapy was administered 15-20 minutes before treatment to promote airway humidification. Using the G1000 vibration expectoration device at 25 Hz, the percussion head remained at each site for 30-60 seconds, with 5-minute sessions three times daily. The percussion head was kept close to the skin and moved slowly from lung apex to hilum and from lung base to hilum. During prone position ventilation, a shallow suctioning protocol was employed, with suction catheter insertion depth less than the length of the endotracheal tube to avoid coughing and agitation during suctioning, which could increase intra-abdominal pressure and threaten the abdominal wound.

### 2.4 Pressure Injury Prevention Nursing Care

This postoperative elderly patient had a Braden score of 12 (high risk) and a nutritional risk score of 5 (severe risk) with poor nutritional status. The air mattress was kept inflated and checked each shift for proper inflation, with bed linens maintained smooth and wrinkle-free. During prone position ventilation, the main pressure points—such as the forehead, sternum, both shoulders, and knees—have minimal muscle and fat padding, making them susceptible to skin injury. Foam dressings and other pressure-relieving materials were applied to protect these areas and reduce pressure, shear, and friction. Special attention was given to turning the head every 1-2 hours to avoid prolonged pressure on the auricles or eyes. After prone positioning, male genitalia and female breasts were checked for compression.

### 2.5 Prevention of Catheter Obstruction and Dislodgement

This postoperative patient had eight catheters of various types: supply catheters (endotracheal tube, central venous catheter); drainage catheters (gastric tube for decompression, indwelling urinary catheter, retained cholecystic bed drainage tube 1, cholecystic bed drainage tube 2, liver margin drainage tube); and monitoring catheters (arterial line). Before turning to prone position, all catheters were inspected and securely fixed to maintain patency and prevent dislodgement throughout the procedure. Transparent dressings were used for dual fixation when necessary. During turning, operators manually stabilized the transparent dressing of central venous catheters to prevent pulling. Adequate sedation was maintained (RASS -4 to -5) to reduce unplanned extubation, with protective restraints applied. Before and after turning, tubing was inspected for kinking, twisting, or displacement, with close monitoring to ensure catheter markings remained consistent with pre-procedure measurements.

### 2.6 Abdominal Wound Care

Throughout the modified prone position ventilation process, attention was paid to wound and dressing condition, as well as the security and patency of wound drainage tubes. The modified prone position provided patient comfort, good tolerance, and reduced skin and mucosal injury. It facilitated clinical observation and nursing care by maintaining the chest at approximately a 60° angle to the bed and placing soft pillows under the chest and abdomen while avoiding surgical wounds. This approach reduced pressure on abdominal wounds, prevented compression, twisting, or dislodgement of abdominal drainage tubes due to positional changes, ensured drainage patency, and enabled nursing staff to conveniently observe drainage and airway patency while facilitating nursing procedures such as infusion and suctioning.

### 2.7 Psychological Care for Patient and Family

Before prone position ventilation, the necessity and precautions were explained to the patient and family to obtain consent and cooperation. Patients were informed about protective restraints and the use of sedative and analgesic medications during prone position ventilation to reduce discomfort.

## Conclusion

Implementing modified prone position ventilation in elderly postoperative purulent cholecystitis patients with lung injury presents significant challenges due to abdominal wounds and multiple catheters. Traditional prone position ventilation requires numerous staff members, and despite clear division of labor, adverse nursing events still occur. After literature review, we implemented a modified prone position ventilation protocol that effectively reduced staffing requirements and decreased the incidence of adverse nursing events. This approach better enables observation and nursing care of abdominal wounds and drainage in post-abdominal surgery patients requiring prone position ventilation. Through comprehensive systematic assessment, standardized implementation protocols, and effective control of each process and detail—with dynamic adjustment based on patient condition—we reduced related complications. Prone position ventilation does not require expensive equipment or medications and does not incur additional medical costs [13], yet it improves treatment outcomes, facilitates successful weaning from invasive mechanical ventilation, and improves clinical outcomes.

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*Note: Figure translations are in progress. See original paper for figures.*