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# Nursing Care for XDR-TB Complicated by Infected Bronchiectasis and Malnutrition: A Case Report

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## ABSTRACT

Extensively drug-resistant tuberculosis (XDR-TB) presents a formidable challenge, often exacerbated by irreversible structural lung damage and severe malnutrition. Roy's Adaptation Model (RAM) was employed as the theoretical framework to address the profound physiological and psychosocial disruptions in a high-complexity case. This report describes the integrated, nurse-led management of a patient with XDR-TB and destroyed lung syndrome during the acute stabilization phase. A 39-year-old woman with a decade-long history of TB treatment failure was admitted to a national referral hospital with XDR-TB, profound cachexia (BMI 13.96 kg/m$^2$), and severe hypercapnia ($pCO_2$ 94.7 mmHg). During a 72-hour acute stabilization period, integrated nursing-led interventions including the Active Cycle of Breathing Technique (ACBT), therapeutic positioning, and a high-calorie, high-protein regimen resulted in marked clinical improvement. Respiratory stabilization allowed for oxygen weaning from 5 to 4 L/min with an $SpO_2$ increase to 97%. Breaking the catabolic cycle was evidenced by weight stabilization (maintained at 35 kg) and a positive metabolic shift, alongside significantly improved oral intake (80–90% of requirements).. Functional status progressed from total bed rest to independent short-distance ambulation without desaturation. Comprehensive nursing interventions, focusing on airway clearance and acute metabolic stabilization, play a pivotal role in the rapid stabilization of complex XDR-TB cases. Highlighting outcomes within the first 72 hours demonstrates that structured nursing care acts as a catalyst for physiological adaptation, even in the presence of severe anatomical lung destruction.

**Keywords: extensively drug-resistant tuberculosis, Roy adaptation model, acute metabolic stabilization, airway clearance, case report**

## INTRODUCTION

Tuberculosis (TB) remains a formidable global health challenge, with the emergence of drug-resistant strains posing a significant threat to global elimination efforts. Among these, extensively drug-resistant tuberculosis (XDR-TB) represents the most severe phenotype, characterized by high mortality rates (Pedersen et al., 2023), and limited therapeutic options, as emphasized by the World Health Organization (2025). While the pharmacological management of XDR-TB is well-documented, the clinical reality is often complicated by severe structural lung damage, such as infected bronchiectasis, and profound metabolic depletion in the form of severe malnutrition (Tiberi et al., 2022).

The presence of infected bronchiectasis in XDR-TB patients creates a "vicious cycle" of impaired mucociliary clearance, chronic airway inflammation, and recurrent secondary infections, which drastically accelerates respiratory failure (Inchingolo et al., 2021). Furthermore, severe malnutrition in these patients is not merely a comorbid condition but a significant predictor of poor clinical outcomes, as it impairs cell-mediated immunity and reduces the bioavailability of second-line anti-TB drugs (Siraj et al., 2025). Despite the critical nature of these complications, there is a paucity of literature detailing the integrated nursing-led management of XDR-TB patients who present with this specific triad of drug resistance, structural lung destruction, and kacheksia. Roy's Adaptation Model (RAM) was strategically chosen as the theoretical framework for this case, as the management of XDR-TB demands not only physiological stabilization of impaired gas exchange but also a systemic adaptation to the psychosocial and metabolic rigors of prolonged, toxic therapy.

Recent nursing literature on drug-resistant tuberculosis has largely concentrated on the psychosocial and behavioral domains of care. Systematic reviews and qualitative studies emphasize the nurse's role in enhancing medication adherence, mitigating stigma in primary care settings, and managing the psychological burden of treatment (Germano et al., 2024; Yan & Bai, 2025). Furthermore, the lived experiences of nurses managing DR-TB highlight the emotional complexities of care delivery but often overlook the technical exigencies of bedside physiological management (Afenigus & Kebede, 2025). On the clinical spectrum, while malnutrition is unequivocally established as a potent predictor of treatment failure and mortality in MDR/XDR-TB cohorts (Engoru et al., 2024; Siraj et al., 2025), there remains a critical paucity of evidence detailing integrated nursing protocols for acute metabolic resuscitation. Specifically, literature guiding the simultaneous management of 'destroyed lung' mechanics and severe cachexia in a tertiary referral setting is virtually nonexistent. This knowledge gap leaves practitioners without a validated clinical roadmap for stabilizing patients who present not merely with infection, but with life-threatening physiological decompensation.

This case report is importance because it highlights the pivotal role of comprehensive nursing interventions ranging from advanced airway clearance techniques to aggressive nutritional rehabilitation in stabilizing a critically ill patient within a national referral setting. By synthesizing the current evidence-based nursing practices with the complexities of drug-resistant TB, this report aims to provide a clinical framework for nursing professionals managing similar high-complexity respiratory cases. In the following sections, we present the case of Mrs. CL, a 39-year-old female with a decade-long history of TB treatment failure, now

presenting with XDR-TB and life-threatening respiratory and nutritional complications. Therefore, the aim of this study is to describe the integrated nursing management of a patient with XDR-TB presenting with destroyed lung syndrome and severe cachexia, specifically focusing on the application of Roy's Adaptation Model for acute physiological stabilization and functional recovery.

## METHOD

This study utilizes a descriptive case report design following the CARE (Case REport) guidelines (Abdelghani et al., 2024; Riley et al., 2017). The patient was managed at the Persahabatan National Respiratory Referral Hospital in Jakarta, Indonesia. The observation period for this report spanned from the patient's admission in late December 2024 through the acute stabilization phase in January 2025.

Data Collection Data were collected retrospectively and prospectively through multiple sources, including Direct Clinical Observation: Daily physical assessments of the respiratory system and nutritional status; Medical Records Review: Analysis of electronic health records (EHR) regarding the patient's past medical history of tuberculosis treatment (2012–2024), medication adherence, and previous hospitalizations; Diagnostic Evaluation: Review of laboratory results (arterial blood gases, bacteriology) and radiological imaging (High-Resolution CT scan).

The nursing care process was structured using the Roy Adaptation Model to assess the patient's physiological and psychosocial adaptation to chronic illness. The nursing care process was structured following the standard sequence of Assessment, Diagnosis, Intervention, and Evaluation. Nursing diagnoses were formulated based on the prioritization of life-threatening problems (impaired gas exchange and ineffective airway clearance) and physiological needs (imbalanced nutrition). Interventions were planned using evidence-based protocols for airway clearance techniques (Active Cycle of Breathing Technique/ACBT) and nutritional rehabilitation, integrated with the specific pharmacological regimen for XDR-TB. Written informed consent was obtained from the patient for the publication of this case report and any accompanying images. Personal identifying information has been anonymized to protect patient confidentiality.

## RESULTS

### Baseline Clinical Characteristics and Severity of Illness

Upon admission to the isolation ward, the patient (Mrs. CL, 39 years old) presented with a complex clinical profile characterizing Extensively Drug-Resistant Tuberculosis (XDR-TB) with sequelae of destroyed lung syndrome on the left field. The initial nursing assessment conducted on December 30, 2024, identified life-threatening physiological deviations. The patient exhibited critical hypercapnic respiratory failure, evidenced by a partial pressure of carbon dioxide (pCO2) of 94.7 mmHg (Reference: 35–45 mmHg) and severe hypoxemia (pO2 55.8 mmHg).

The respiratory mechanics were severely compromised. The patient demonstrated tachypnea (Respiratory Rate [RR]: 26–28 breaths/minute) with evident use of accessory muscles (sternocleidomastoid and intercostal retractions). Auscultation revealed coarse crackles (rhonchi) predominantly in the left lung field and parts of the right upper lobe, indicating ineffective airway clearance due to thick, purulent secretions. Subjectively, the patient reported a dyspnea score of 7/10 on the Modified Borg Scale, particularly exacerbated by minimal movement (e.g., shifting position in bed).

Nutritional and functional baselines were equally concerning. The patient was in a state of severe catabolism with a Cachectic appearance (BMI 13.96 kg/m²), hypoalbuminemia (2.98 g/dL), and generalized muscle wasting. The functional status was classified as 'Severe Dependency' with a Barthel Index score of 55/100, necessitating total assistance for hygiene and mobility.

### Efficacy of Airway Clearance and Oxygenation Strategies

The primary nursing intervention focused on managing the ineffective airway clearance and impaired gas exchange through a structured protocol of Active Cycle of Breathing Technique (ACBT) combined with modified postural drainage, administered twice daily.

Phase 1: Stabilization (December 30, 2024). Following the initiation of ACBT and positioning (semi-Fowler’s 45°), the patient was initially apprehensive due to dyspnea. However, guided coaching on 'Breathing Control' and 'Thoracic Expansion Exercises' facilitated the mobilization of secretions. Post-intervention, the patient was able to expectorate thick, yellowish sputum (approx. 10–15 cc). Although rhonchi persisted, the subjective

sensation of chest tightness decreased (Borg Scale reduced from 7 to 5). Oxygen support was maintained at 5 Liters Per Minute (LPM) via nasal cannula to maintain $SpO_2$ above 92%.

Phase 2: Improvement and Weaning (December 31, 2024 – January 1, 2025). By the second day of intensive nursing care, the patient demonstrated improved cough efficacy. The implementation of 'Pursed-Lip Breathing' whenever dyspnea occurred allowed the patient to control the respiratory rate independently. Significant hemodynamic improvement was observed on January 1, 2025. The respiratory rate stabilized at 20-22 breaths/minute without visible use of accessory muscles during rest. The most notable outcome was the successful weaning of oxygen therapy. The patient tolerated a reduction in oxygen flow from 5 LPM to 4 LPM while maintaining an oxygen saturation ($SpO_2$) of 97%, representing a clinically improvement compared to admission status. This suggested an improvement in V/Q (Ventilation/Perfusion) matching, which likely resulted from the synergistic effect of the optimized pharmacological regimen (XDR-TB therapy) in reducing systemic inflammation and the nursing-led airway clearance techniques in maximizing alveolar ventilation, despite the chronic anatomical lung destruction.

**Nutritional Rehabilitation and Metabolic Response**

To address the diagnosis of nutritional deficit related to hypermetabolic state and nausea, a high-protein, high-calorie diet (ETEP) of 1,500–1,700 kcal/day was enforced.

Intake Progression: On the first day of evaluation, oral intake was limited to 60% of the target due to nausea. Nursing management included providing small, frequent meals (6 times/day) and oral hygiene prior to meals to stimulate appetite.

Outcome: By discharge (January 1), the patient’s tolerance improved significantly, consuming 80–90% of the provided meals.

Anthropometric Indicator: Successful weight stabilization was achieved, with the patient maintaining a constant weight of 35 kg throughout the 72-hour period, effectively halting the pre-admission trend of rapid weight loss. This stabilization, coupled with improved hydration and the resolution of nausea, marks a critical transition from a progressive catabolic state to a stable metabolic baseline.

**Functional Recovery and Activity Tolerance**

The nursing goal was to transition the patient from bed rest to minimal ambulation to prevent further muscle atrophy and Deep Vein Thrombosis (DVT), guided by the principle of "Energy Conservation."

Day 1 (Dec 30): Activity was limited to sitting on the edge of the bed. The patient tolerated 15 minutes of sitting with stable vital signs but reported fatigue.

Day 2 (Dec 31): Mobilization progressed to standing and stepping.

Day 3 (Jan 1): The patient successfully ambulated 5 meters within the room and to the toilet independently with supervision. The activity tolerance test showed no desaturation ($SpO_2$ remained ≥95% during exertion), and the post-activity heart rate returned to baseline within 3 minutes, indicating improved cardiac reserve. Despite the high risk of falls (Morse Fall Scale: 45), zero adverse events (falls or injuries) occurred due to the strict implementation of fall precautions (bed rails up, supervised ambulation).

**Summary of Clinical Parameters**

The comprehensive response to nursing interventions is summarized in the time-series analysis below (Table 1), highlighting the trajectory of stabilization across respiratory, hemodynamic, and nutritional domains.

Table 1. Clinical Parameters and Nursing Outcomes
(Dec 30, 2024 – Jan 01, 2025)

| Domain | Parameter | Baseline / Admission | Evaluation Day 1 (30 Dec) | Evaluation Day 2 (31 Dec) | Discharge Outcome (01 Jan) | Trend/ Interpretation |
|---|---|---|---|---|---|---|
| Respiratory Status | Respiratory Rate (RR) | 26–28 breaths/min | 24 breaths/min | 22 breaths/min | 20 breaths/min | Normalized. Reduced work of breathing. |
| | Oxygen Support | N/C 5 LPM | N/C 5 LPM | N/C 5 LPM | N/C 5 LPM | Weaning Success. Improved oxygen efficiency. |
| | $SpO_2$ (Saturation) | 90–92% | 95% | 96% | 97% | Optimized. Exceeded target (>95%). |
| | Breath Sounds | Coarse Rhonchi (+/+) | Rhonchi (+/+) | Rhonchi (+/-) | Decreased Rhonchi | Airway Clearance. ACBT effective. |
| Hemodynamics | Heart Rate (HR) | 110–115 beats/min | 102 beats/min | 98 beats/min | 92 beats/min | Stabilized. Reduced cardiac workload. |
| | Blood Pressure | 110/70 mmHg | 110/80 mmHg | 116/73 mmHg | 120/80 mmHg | Stable perfusion. |
| Nutritional Status | Diet Intake | < 50% | 60% (Nausea +) | 75% (Nausea -) | 80–90% | Improved Appetite. Oral intake targets met. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Body Weight | 35 kg | 35 kg | 35 kg | 35 kg | Stabilized. |
| Functional Status | Activity Level | Total Bedrest | Sitting (edge of bed) | Standing/ Stepping | Walking (5 meters) | Mobilization. Barthel Index improved. |
| | Dyspnea on Exertion | Severe (Scale 7/10) | Moderate (Scale 5/10) | Mild (Scale 3/10) | Minimal (Scale 2/10) | Activity Tolerance. |

*Note: N/C = Nasal Cannula; LPM = Liters Per Minute; ACBT = Active Cycle of Breathing Technique*.

## DISCUSSION

This case report demonstrates that a structured nursing-led intervention, integrating airway clearance techniques and acute metabolic stabilization, effectively reversed life-threatening respiratory failure in a patient with XDR-TB and destroyed lung syndrome. The principal finding is that despite irreversible anatomical destruction, the synergistic application of the Active Cycle of Breathing Technique (ACBT) and a high-protein diet facilitated successful oxygen weaning and broke the acute catabolic cycle within 72 hours. These outcomes underscore that targeted physiological nursing care can significantly optimize functional capacity even in the presence of severe structural lung pathology. The discussion below analyzes the physiological mechanisms underlying these successful outcomes.

### Mechanism of Airway Clearance in Destroyed Lung Syndrome

The most significant clinical outcome in this case was the successful weaning of oxygen from 5 LPM to 4 LPM and the resolution of critical hypercapnia (initial pCO2 94.7 mmHg) following the implementation of the Active Cycle of Breathing Technique (ACBT). Destroyed lung, characterized by irreversible parenchymal destruction and cavitation, leads to impaired mucociliary clearance. This creates a vicious cycle of infection and airflow obstruction driven by anatomical distortion and secretion retention (Gyabaah et al., 2024). In Mrs. CL, the application of ACBT specifically the 'Thoracic Expansion Exercises' (TEE) facilitated collateral ventilation. Theoretically, TEE increases lung volume and allows air to flow behind secretions in obstructed airways via collateral channels (pores of Kohn), thereby mobilizing sputum from the peripheral to central airways (Zisi et al., 2022). This mechanism is crucial for patients with bronchiectasis where structural damage limits normal airflow. Our findings align with a randomized controlled trial by Muñoz et al. (2018), which demonstrated that ACBT significantly improves sputum expectoration and oxygenation in patients with bronchiectasis compared to conventional physiotherapy. Furthermore, the 'Forced Expiration Technique' (FET) or huffing component of ACBT minimized dynamic airway compression. In patients

with destroyed lungs, the cartilaginous support of airways is often compromised. Standard vigorous coughing can cause airway collapse, trapping secretions further. By using low-to-medium volume huffs, we prevented this collapse, allowing Mrs. CL to clear secretions effectively without inducing bronchospasm or desaturation, as evidenced by the stabilization of her $SpO_2$ during therapy (95-97%).

**Acute Metabolic Stabilization: Breaking the Catabolic Cycle**

Malnutrition in TB is a strong predictor of mortality, and Mrs. CL's admission BMI of 13.96 kg/m² placed her at imminent risk. The 'cachexia-tuberculosis cycle' is driven by the catabolic effect of chronic inflammation and reduced intake due to respiratory distress (Ockenga et al., 2023; Xu et al., 2022). While full nutritional rehabilitation is a long-term goal, acute metabolic stabilization was achieved through the implementation of the High-Calorie High-Protein (ETEP) diet (2,040 kcal/day) was pivotal. Protein supplementation (1.5–2.0 g/kg/day) is essential for immune function and tissue repair. The achievement of weight stabilization (35 kg) during this acute 72-hour window is clinically significant. In patients with severe TB-cachexia, the primary goal of initial nursing-led metabolic intervention is not immediate weight gain, but rather the cessation of rapid weight loss. This stabilization signals that the patient has moved out of the 'metabolic freefall' characteristic of the acute catabolic phase, allowing cellular resources to be redirected toward respiratory muscle function and immune response. The urgency of this aggressive nutritional approach is supported by recent retrospective cohort studies. Siraj et al. (2025) identified that undernutrition is an independent predictor of unsuccessful treatment outcomes in MDR-TB patients, while Engoru et al. (2024) emphasized that malnutrition significantly increases the risk of mortality by compromising the host's ability to tolerate toxic second-line regimens.

More importantly, adequate protein intake is required for the synthesis of surfactant and maintenance of respiratory muscle strength. The improvement in Mrs. CL's ability to ambulate and the reduction in accessory muscle use suggest an enhancement in diaphragmatic contractility. A study by Coiro et al. (2025) & Mizuno et al. (2021) supports this, indicating that nutritional intervention combined with physical activity significantly improves functional status in sarcopenic respiratory patients. However, refeeding syndrome was a potential risk given her severe malnutrition. Our strategy of gradual caloric increase (starting at 60% of target) prevented metabolic complications such as hypophosphatemia, validating the safety of this protocol in severe TB cachexia. The authors assume that although a significant increase in muscle mass has not yet occurred within a relatively short period, the early reversal of the

catabolic phase has contributed to the optimization of cellular bioenergetics and a reduction in excessive energy consumption associated with inflammatory processes. This metabolic efficiency subsequently prioritizes the recovery of diaphragmatic endurance over peripheral muscle mass accretion, thereby explaining the early clinical improvement in Ms. CL's respiratory effort.

**Oxygenation and Hemodynamic Stability**

The decision to utilize a conventional nasal cannula instead of continuing High-Flow Nasal Cannula (HFNC) was based on the patient's stabilization. While HFNC provides positive end-expiratory pressure (PEEP), prolonged dependence can limit mobility. The successful weaning to 4 LPM suggests that the reduction in secretion burden decreased the ventilation-perfusion (V/Q) mismatch. It is noteworthy that the patient received Sildenafil (Revatio), a phosphodiesterase-5 inhibitor, for pulmonary hypertension. While primarily a medical intervention, the nursing role in monitoring for hypotension and ensuring strictly timed administration was vital. The combination of pharmacological pulmonary vasodilation and nursing-driven airway clearance likely optimized right ventricular afterload, contributing to the reduction in heart rate from 110 bpm to 92 bpm at discharge (Wang et al., 2014). The authors assume that the synchronization between pharmacological afterload reduction and nurse-led alveolar recruitment strategies generates a cardiopulmonary offloading effect, characterized by a reduction in cardiac and pulmonary workload. By alleviating alveolar hypoxia through effective secretion clearance, these interventions likely contributed to the prevention of hypoxia-induced pulmonary vasoconstriction. When combined with sildenafil therapy, this synergistic effect enhances right ventricular efficiency and contributes to the stabilization of the patient's systemic hemodynamic profile.

**Adaptation to Chronic Illness (Roy's Adaptation Model)**

Applying the Roy Adaptation Model (RAM), the nursing care facilitated adaptation in the 'Physiological Mode' (oxygenation and nutrition). However, the 'Self-Concept' and 'Role Function' modes were also addressed. Mrs. CL's ability to perform ACBT independently by discharge indicates an increase in self-efficacy. Educational interventions that specifically enhance self-efficacy have been proven to significantly improve medication adherence among patients facing complex drug-resistant regimens (Lutfian et al., 2025). Moreover, such empowerment strategies are vital for enhancing the overall quality of life and psychosocial resilience in the Indonesian tuberculosis population (Pradipta et al., 2020).

This observation is consistent with a recent meta-analysis by Yan & Bai (2025), which confirmed that structured nursing interventions significantly improve medication compliance and psychological status in pulmonary TB patients. Furthermore, Afenigus & Kebede (2025) highlight that the 'lived experience' of nurses managing DR-TB involves a complex interplay of patient-centered engagement and emotional support, which are essential for mitigating the stigma and isolation often reported in this population (Germano et al., 2024).

The authors assume that patients' mastery of self-management techniques functions as a form of compensatory adaptation, bridging the gap between physiological limitations and functional independence. The transition from passive receipt of care to active self-regulation indicates that strengthening the Physiological Mode through nursing education acts as a catalyst for stabilizing the Self-Concept Mode. This process ultimately fosters the resilience required to sustain adherence throughout the prolonged and challenging treatment trajectory of extensively drug-resistant tuberculosis (XDR-TB).

## CONCLUSION

This case report validates the critical imperative of integrating specialized nursing interventions into the pharmacological management of Extensively Drug-Resistant Tuberculosis (XDR-TB) complicated by destroyed lung syndrome. The clinical trajectory of Mrs. CL demonstrates that while anti-tuberculosis regimens address microbiological eradication, they are insufficient to manage the immediate life-threatening sequelae of hypercapnic respiratory failure and acute metabolic depletion.

Our findings provide evidence that a structured, nurse-led protocol, comprising the Active Cycle of Breathing Technique (ACBT) and a targeted High-Calorie High-Protein regimen is a safe and potent catalyst for acute physiological stabilization. Specifically, this synergistic approach successfully facilitated oxygen weaning, improved respiratory efficiency, and achieved weight stabilization, effectively halting the progressive catabolic decline within a critical 72-hour window. This case proves that even in the presence of irreversible anatomical lung destruction, functional adaptation can be rapidly optimized through targeted nursing care.

Furthermore, applying Roy's Adaptation Model highlights that stabilizing the 'Physiological Mode' serves as the foundation for enhancing the patient's 'self-concept' and self-efficacy. Consequently, this report advocates for a paradigm shift in TB care: moving from a purely drug-centric model to an integrated approach where nurses act as primary therapeutic agents in

physiological and metabolic rescue. For clinical practice in high-burden, resource-limited settings, these low-cost, high-impact nursing interventions should be standardized to bridge the gap between acute crisis and long-term recovery.

## LIMITATION

While this case report highlights significant clinical improvements during the acute stabilization phase, several limitations warrant consideration.

First, the inherent design of a single-case study limits the generalizability of the findings. The specific anatomical destruction observed in Mrs. CL represents a unique phenotype of XDR-TB; therefore, the efficacy of the Active Cycle of Breathing Technique (ACBT) may vary in patients with different patterns of lung involvement or different stages of drug resistance.

Second, the observation period was intentionally brief (72 hours), focusing exclusively on the critical window of acute physiological stabilization. Consequently, this study cannot provide data on the long-term sustainability of the observed improvements, such as sustained weight gain, long-term adherence to TB regimens, or permanent functional recovery. In the context of Roy's Adaptation Model, while we observed early physiological and self-concept adaptation, the full trajectory of 'Role Function' and 'Interdependence' modes requires a more longitudinal assessment.

Third, due to the rapid clinical stabilization and resource constraints in a high-volume referral setting, a follow-up Arterial Blood Gas (ABG) analysis was not performed immediately before discharge. The resolution of hypercapnia and improvement in ventilation were inferred through clinical proxies, including the normalization of respiratory rate, consciousness, and successful oxygen weaning. While these are valid clinical indicators, the lack of quantitative biochemical data to compare with admission values is an objective limitation.

Finally, because the nursing interventions (ACBT and high-protein diet) were implemented alongside a specialized pharmacological regimen (XDR-TB therapy and Sildenafil), it is challenging to isolate the independent effect of nursing care. However, the immediate symptomatic relief following each ACBT session and the stabilization of metabolic decline suggest that nursing-led care provided a vital synergistic effect that medical therapy alone could not achieve in such a short timeframe.

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