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Exploration of a Multidisciplinary Rescue Model for Critically Ill Pregnant Women: A Case Study of Pregnancy Complicated by Hematogenous Tuberculosis and Tuberculous Meningitis

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Case Report

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Abstract

This paper details a case of a critically ill 24-year-old pregnant woman in late gestation who presented with disseminated pulmonary tuberculosis, tuberculous meningitis, active hepatitis B virus replication, and multiple complications.The patient presented in critical condition with impaired consciousness and severe intracranial hypertension, confirmed through imaging studies and cerebrospinal fluid (CSF) microbiological testing. The treatment process faced multiple severe challenges, including anti-tuberculosis therapy (requiring comprehensive consideration of drug penetration through the blood-brain barrier, potential drug resistance, and fetal safety), intracranial pressure control, enhanced nutritional support, and management of multiple comorbidities. Our hospital established a multidisciplinary team (MDT) comprising specialists from Critical Care Medicine, Respiratory Medicine, Obstetrics and Gynecology, and Hepatology. This team developed a dynamic, individualized treatment plan that ultimately stabilized the patient's condition.This case highlights the complex clinical features and diagnostic challenges associated with severe tuberculosis during pregnancy, demonstrating the critical role of the MDT model in improving outcomes for critically ill pregnant women.

Introduction

Tuberculosis (TB) is a chronic infectious disease caused by Mycobacterium tuberculosis (MTB). Its primary mode of transmission is through the air, also known as droplet nuclei transmission. Currently, tuberculosis remains a significant global public health issue and one of the leading causes of death from infectious diseases worldwide[1]. During pregnancy, elevated levels of estrogen and progesterone in the mother's body can suppress T lymphocyte function, thereby increasing the risk of tuberculosis infection. Tuberculosis during pregnancy may result from either a new infection occurring during gestation or the progression or recurrence of pre-existing, untreated tuberculosis[2, 3]. Although the specific mechanisms by which pregnancy affects tuberculosis risk remain unclear, studies indicate that pregnancy may increase the risk of developing tuberculosis by two to three times[4]. Another perspective holds that pregnancy itself does not directly increase susceptibility to tuberculosis nor necessarily alter disease progression. The key reason lies in the unique physiological changes during pregnancy, such as neuroendocrine regulation and immunosuppression, which may mask or confound typical tuberculosis symptoms, making them difficult to detect. Concurrently, the nonspecific discomforts commonly experienced during pregnancy can easily overlap with the early manifestations of tuberculosis. This overlap often leads to delayed diagnosis, ultimately increasing the risk of latent infection progressing to active tuberculosis[2, 5, 6]. The true global prevalence of tuberculosis during pregnancy remains unclear. Due to the absence of typical symptoms in many affected women, a significant number of pregnant women with active tuberculosis may go undetected. Furthermore, considering the potential risks of imaging tests to the fetus, diagnosis and treatment of tuberculosis during pregnancy are often delayed. It is estimated that up to 40% of affected women may fail to receive timely diagnosis and treatment[2, 7, 8]. Approximately 108 million people worldwide contract TB annually[9], with tuberculous meningitis (TBM) representing its most severe clinical form. This condition arises when Mycobacterium tuberculosis

spreads from the lungs to the brain. The disease typically presents insidiously with a slow progression, characterized by persistent headaches lasting days to weeks, neck stiffness, and fever. Early diagnosis and prompt treatment before the onset of coma can significantly reduce mortality and disability risks[10].

Early diagnosis of tuberculosis during pregnancy is particularly crucial, yet the optimal diagnostic strategy and effective treatment regimen remain unclear. Notably, due to limited relevant literature, clinical diagnosis of late-pregnancy cases complicated by hematogenous disseminated pulmonary tuberculosis and tuberculous meningitis still presents significant challenges. This paper reports a case of late-pregnancy hematogenous disseminated pulmonary tuberculosis complicated by tuberculous meningitis, with concomitant hepatitis B "big three positive" status. Through systematic analysis of the diagnostic and therapeutic process, it aims to provide clinical reference for improving the success rate of early diagnosis and treatment of tuberculosis in pregnant women.

Case Report

Patient, female, 24 years old, Tibetan ethnic group, pastoralist, G1P0 (first pregnancy, no previous deliveries), 30 weeks+ gestation. Transferred to our hospital's Critical Care Medicine Department on October 10, 2025, presenting with "intermittent headaches with vomiting for 2 weeks, worsening with low back pain for 1 week." The patient has a history of close contact with tuberculosis patients. Poor mental status with drowsiness, temperature 38°C (98.6°F). ECG monitoring: Heart rate: 90 beats/min, Respiratory rate: 25 breaths/min, Blood pressure: 125/75 mmHg, Oxygen saturation: 97% (on nasal cannula oxygen at 2 L/min). Physical examination: Positive neck stiffness, positive Kernig's sign and Brudzinski's sign, right eye conjunctival injection, no icterus of skin or mucous membranes, no rash, petechiae, subcutaneous nodules, or scars. sclera without icterus, pupils equal in size and round, with brisk light reflexes, no cyanosis of lips, tonsils not enlarged. the chest is symmetrical, coarse breath sounds are heard in both lungs, no dry or wet rales are audible, no pleural friction rub is present. Heart rate is 90 beats per minute with regular rhythm, no murmurs are heard in any valvular auscultation area. The abdomen is flat, tenderness is present in the right lower quadrant without rebound tenderness, the liver and spleen are not palpable below the costal margin, no shifting dullness is present, bowel sounds are normal at 4 per minute, no edema in both lower extremities. Afistula is visible in the right renal region, with yellow urine observed draining. The patient's treatment timeline and outcomes are as follows:

Diagnosis and Initial Stabilization Phase (October 6–10, 2025) Medical History and Referral: The patient presented to Qinghai Red Cross Hospital on October 6, 2025, complaining of "low back pain for 3 days." A comprehensive urinary system color Doppler ultrasound revealed "significant hydronephrosis of the right renal pelvis." Following consultation with the urology department, a "right nephrostomy" was performed. Postoperatively, the low back pain improved. Subsequently, the patient developed persistent headaches. Lumbar puncture revealed intracranial pressure >330 mmH_2O. Cerebrospinal fluid Xpert MTB/RIF testing indicated "trace Mycobacterium tuberculosis, rifampicin resistance not confirmed." Cerebrospinal fluid examination (Table 1, October 10) revealed typical tuberculous meningitis changes: elevated nucleated cell count (130×10^6/L), markedly increased protein (2.37 g/L), and significantly decreased glucose (0.59

mmol/L) and chloride levels, confirming the diagnosis of tuberculous meningitis. To determine the source of the tuberculous meningitis, a chest CT scan (Figure 1) was performed, revealing diffuse miliary nodules in both lungs. This led to a diagnosis of hematogenous disseminated pulmonary tuberculosis. Initial Treatment: Given the patient's late pregnancy, a lumbar cisternal cerebrospinal fluid catheterization procedure was performed to control life-threatening intracranial hypertension. Urgent Blood Gas Analysis: pH 7.49, $PaCO_2$ 24 mmHg, PaO_2 95 mmHg, Na^+ 123 mmol/L, K^+ 3.2 mmol/L, Ca^{2+} 1.07 mmol/L, Glu 7.4 mmol/L, Lac: 1.4 mmol/L, HCO3- 18.3 mmol/L, HCO3-std 21.8 mmol/L, BEefc -5.0 mmol/L, BE(B) -4.0 mmol/L, THbc: 93 g/L. Inflammatory Markers: White Blood Cell Count (WBC) 8.05 × 10^9/L, Neutrophil Percentage (NEUT) 86.20%, Red Blood Cell Count (RBC) 3.79 × 10^{12}/L, Hemoglobin (HGB) 98 g/L, Prothrombin Time (PT) 10.5 s, Prothrombin Time Ratio (PT/INR) 1.00, Prothrombin Time (PT) 10.5 s, Prothrombin Time Ratio (Red blood cell count (RBC) 3.79 × 10^{12}/L, Hemoglobin (HGB) 98 g/L, Procalcitonin (PCT) measurement: PCT 0.08 ng/mL, NT-proBNP 171 pg/mL. Immediately request urgent consultation from the Respiratory and Obstetrics/Gynecology departments, then initiate the initial anti-tuberculosis regimen: Isoniazid 0.6g + Rifampicin 0.45g + Ethambutol 0.75g, Furosemide injection 20mg Q12h, and actively correct electrolyte imbalances such as hyponatremia and hypokalemia.

Complication Identification and Protocol Adjustment Phase (October 11–15, 2025) Complication Diagnosis: Concurrent Infection: Patient's body temperature peaked at 38.7°C. Pathogen identification: Respiratory virus IgM antibody testing indicated Mycoplasma pneumoniae (MP) positivity, while sputum culture revealed oral Candida albicans infection. Renal fistula drainage fluid tested negative for routine bacterial culture, acid-fast staining, and Xpert testing. The condition is tentatively attributed to late-pregnancy uterine compression of the ureter. Thyroid function tests revealed: T4 199.10 nmol/L, TSH 5.022 mIU/L, FT3 3.07 pmol/L, consistent with subclinical hypothyroidism during pregnancy. Treatment included oral azithromycin 250mg once daily for antiviral therapy, plus levothyroxine sodium tablets 25μg once daily orally. Follow-up thyroid function tests were scheduled. HBV-DNA load was elevated at 1.94×10^8 IU/ml, indicating active hepatitis B virus replication. Severe iron deficiency anemia was present (HGB dropped to a minimum of 83 g/L).Multidisciplinary Diagnosis and Treatment Optimization: On October 15, 2025, with a peak body temperature of 39°C, an MDT discussion weighed the risks of unclear rifampicin resistance against the drug's potential fetal toxicity. It was decided to escalate the anti-tuberculosis regimen to: Isoniazid 0.6g + Rifampicin 0.45g + Linezolid 0.6g qd + Moxifloxacin 250ml for anti-TB therapy. Ethambutol discontinued (combined with linezolid increases risk of fetal retrobulbar optic neuritis toxicity). Active hepatitis B virus replication. and hepatitis B "big three positive" status necessitated antiviral therapy with tenofovir disoproxil fumarate 0.3 g. Oral candidiasis was actively treated with topical nystatin mouthwash.

Fluctuations in Clinical Condition and Perinatal Management Phase (October 16–24, 2025): Condition Monitoring and Response: During this period, the patient's cerebrospinal fluid cell count exhibited a transient peak on October 19 (380 × 10^6/L, Table 1). The highest body temperature recorded was 38.2°C, with fever predominantly occurring in the afternoon. Empirical antimicrobial therapy was initiated with ceftriaxone sodium 4 g once daily. Subsequently, the patient's temperature gradually decreased, with a maximum of 37.5°C, eventually dropping to 36.8°C by October 21. Inflammatory markers in the

cerebrospinal fluid (cell count, protein) began showing a steady downward trend (Table 1, October 21 and 23), indicating that the intensive anti-tuberculosis treatment was proving effective. Obstetric Monitoring: Regular bedside color Doppler ultrasound monitoring of fetal growth and development was conducted, with intravenous vitamin C administered for antioxidant effects and cell membrane stabilization. By October 24, the patient's headache had significantly improved, and intracranial pressure decreased to 160 mmH_2O. The lumbar cisternal drainage tube was then removed to prevent retrograde long-term infection. At this point, the pregnancy was at 33 weeks, The patient's condition stabilized, and her family requested discharge. Given her severe condition, she was transferred to the Respiratory Department for continued anti-tuberculosis treatment until discharge on November 5 to await delivery. During treatment, the patient was instructed to enhance nutritional intake. Following a consultation with the Nutrition Department, a nutritional support plan was developed based on her body weight and gestational nutritional requirements. This included supplementation with protein powder, human albumin, and compound amino acid injections. The patient was admitted to the Department of Obstetrics and Gynecology at Qinghai Provincial Fourth People's Hospital on November 11 with chief complaints of intermittent headache and vomiting for one week, accompanied by fever for one day. On November 14, lumbar puncture revealed intracranial pressure of 130 cmH_2O. The patient's amniotic fluid index was 71 mm, with the largest amniotic fluid pocket measuring 26 mm. The family requested a cesarean section. On November 19, a "lower segment cesarean section" was performed, delivering a live female infant in cephalic presentation. Birth weight was 2320g, with an Apgar score of 8 at 1 minute. As the newborn was preterm, she received hepatitis B vaccine and hepatitis B immunoglobulin before being transferred to Qinghai Provincial Maternal and Child Health Hospital. Both the patient and newborn were discharged without complications on December 1.

Table 1. Dynamic Changes in Cerebrospinal Fluid Parameters During Treatment in a Pregnant Patient with Miliary Tuberculosis and Tuberculous Meningitis

Parameter	Reference Range	10-10	10-13	10-16	10-19	10-21	10-23	11-14
Routine Analysis								
Color		Colorless	Colorless	Light Yellow	Light Yellow	Light Yellow	Light Yellow	Light Yellow
Turbidity		Clear	Clear	Clear	Clear	Clear	Clear	Clear
Clot		None	None	None	None	None	None	None
P-Qual		+++	+++	+++	+++	++	++	+
TNC ($\times 10^6$/L)	0-10	130	98	180	**380**	**160**	**72**	**60**
Mono (%)		90	30	30	40	40	45	20
Poly (%)		10	70	70	60	60	55	80
Biochemical Analysis								
K^+, mmol/L	2.5-3.5	2.22	2.97	2.26	2.46	3.20	3.03	2.68
Na^+, mmol/L	135-150	124.0	136.4	137.0	134.7	139.1	143.9	138.4
Cl^-, mmol/L	119-126	104.8	116.0	115.9	115.8	112.9	119.4	116.7
GLU, mmol/L	2.8-5.5	0.59	0.77	0.52	0.49	1.16	0.37	1.11
LDH, U/L	3-50	190	140	121	185	86	94	54
ADA, U/L	0-8	5.32	10.43	10.76	8.68	7.58	8.15	5.97
CSF TP, g/L	0.008-0.43	2.37	2.70	2.58	2.57	1.78	1.61	1.44

Abbreviations: 1.P-Qual, Protein Qualitative; TNC, Total Nucleated Cell Count; Mono, Mononuclear Cells; Poly, Polymorphonuclear Cells, CSF, cerebrospinal fluid; LDH, Lactate Dehydrogenase; ADA, Adenosine Deaminase. 2.The reference ranges are approximate and may vary between laboratories. 3.Bold data highlights key parameters with significant changes or turning points compared to the previous test.

Table 2. Serial Prenatal Sonographic Measurements

Parameter	14-Oct-25	18-Oct-25	21-Oct-25	11-Nov-25
BPD (mm)	77	78	77	86
AFL (mm)	58	60	58	71
AC (mm)	267	-	-	307
Amniotic Fluid	MVP: 67	AFI: 132	AFI:103, MVP: 37	AFI:71,MVP: 26
FHR (bpm)	163	155	152	167
Placental location	Anterior	Anterior	Anterior	Anterior
Placental grade	0	I	I	II
US-EGA	30w5d	31w2d	32w4d	35w3d
Interpretation	IUP (Cephalic)	IUP (Cephalic)	Viable IUP	Viable IUP

Abbreviations: AC, Abdominal Circumference; AFI, Amniotic Fluid Index; BPD, Biparietal Diameter; EGA, Estimated Gestational Age; FHR, Fetal Heart Rate; FL, Femur Length; IUP, Intrauterine Pregnancy; MVP, Maximal Vertical Pocket; US, Ultrasound; bpm, beats per minute; w, weeks; d, days.

Discussion

Tuberculosis can affect all organ systems throughout the body, including the central nervous system. TBM accounts for approximately 6% of all extrapulmonary tuberculosis cases and represents one of the most severe clinical forms of the disease, characterized by high mortality rates and frequent neurological sequelae[11]. The incidence of tuberculosis during pregnancy is approximately 1%–2%[12], Clinical diagnosis is often challenging, and identifying tuberculosis in pregnant women becomes particularly complex under conditions of limited medical resources.

Tuberculosis of the central nervous system primarily includes TBM, tuberculous arachnoiditis of the spinal cord, and intracranial tuberculomas[13]. This patient received a definitive diagnosis via lumbar puncture during late pregnancy and did not undergo subsequent cranial MRI. The patient tested negative for HIV and had no history of immunosuppression or related clinical indications. However, the patient reported a history of close contact with tuberculosis (her sister was diagnosed with tuberculosis). At approximately 28 weeks of gestation, the patient developed signs and symptoms of tuberculous meningoencephalitis, with a clearly identified primary pulmonary tuberculosis lesion present. Pregnancy itself may be a risk factor for tuberculosis. Research indicates that increased susceptibility to tuberculosis during pregnancy may be associated with changes in the immune status during gestation: to protect the fetus from immune rejection, pregnancy partially suppresses type 1 helper T cell (Th1)-mediated cellular immunity while enhancing type 2 helper T cell (Th2)-mediated antibody immune responses. Since the body's defense against Mycobacterium tuberculosis primarily relies on cellular immunity, and active tuberculosis is associated with a pronounced Th2 immune response, this pregnancy-related immune shift may promote the progression of latent infection to active disease[14].

Timely detection and appropriate treatment are crucial for minimizing the morbidity and mortality associated with TBM. The definitive diagnosis of this disease requires a comprehensive evaluation of clinical manifestations, epidemiological characteristics of the patient's region of residence, imaging findings, and laboratory test results[15]. The laboratory diagnosis of TBM primarily relies on the detection of acid-fast bacilli in cerebrospinal fluid smears or the isolation and culture of MTB using solid culture media[16]. Although Ziehl-Neelsen acid-fast staining provides rapid results, its sensitivity is relatively low, ranging only from 10% to 20%. In contrast, bacterial culture offers higher sensitivity (up to 60%–70%), but typically requires at least two weeks or longer to observe bacterial growth, and sometimes still fails to yield positive results. Consequently, the timeliness of culture methods often falls short of meeting the demands for rapid clinical diagnosis[17]. Lumbar puncture is crucial for differentiating various types of meningitis. In tuberculous meningitis, cerebrospinal fluid often appears pale yellow. Laboratory analysis typically reveals lymphocytosis, elevated protein levels, and decreased glucose content[18]. The patient's cerebrospinal fluid analysis results are consistent with the typical presentation of TBM. Although viral meningitis may also present with similar cerebrospinal fluid changes, it cannot be entirely ruled out. Testing cerebrospinal fluid adenosine deaminase (ADA) levels holds high diagnostic value for distinguishing TBM from non-tuberculous meningitis in immunocompetent patients, with sensitivity ranging from 75% to 94% and specificity from 86% to 97%[19]. However, repeated lumbar puncture tests in this patient showed no significant elevation in ADA levels. (86–97%) GeneXpert MTB/RIF testing requires less time than traditional culture methods. Although this technique has relatively low sensitivity in diagnosing TBM, it demonstrates high specificity. The patient's test results indicated "trace amounts of Mycobacterium tuberculosis with indeterminate rifampicin resistance." Combined with routine cerebrospinal fluid (CSF) and biochemical examinations, the diagnosis of TBM was ultimately confirmed. Lumbar puncture revealed intracranial pressure (ICP) ≥330 mmH_2O, necessitating urgent ICP reduction measures. According to the U.S. FDA pregnancy drug classification, mannitol crosses the placental barrier and is classified as Category C. Glycerol fructose lacks sufficient clinical research data in pregnant women. Therefore, any medication decision must be based on a rigorous assessment of maternal and fetal benefits versus risks. After comprehensive consideration, our team ultimately selected symptomatic treatment via lumbar cisternal drainage of cerebrospinal fluid to control intracranial pressure[20,21]. By titrating cerebrospinal fluid to monitor intracranial pressure levels, we can further alleviate the patient's headache symptoms.

Tuberculous meningitis represents the most severe clinical form of Mycobacterium tuberculosis infection. Interfering with the efflux mechanisms of the blood-brain barrier and blood-cerebrospinal fluid barrier to enhance the delivery of anti-tuberculosis drugs to the brain and cerebrospinal fluid may serve as a potential strategy to improve treatment efficacy[22,23].

Previous studies have confirmed that the permeability of isoniazid and pyrazinamide in cerebrospinal fluid approaches complete equilibrium with plasma[24]. In cases of meningitis, the concentration of rifampin and rifapentine in cerebrospinal fluid can reach up to 20% of their blood levels, indicating effective penetration through the blood-brain barrier into the brain. Although oxazolidinone antibiotics such as

linezolid and canithiazole demonstrate good penetration into cerebrospinal fluid, they carry a higher risk of bone marrow suppression[25,26]. The cerebrospinal fluid permeability of fluoroquinolone antibiotics (such as levofloxacin and moxifloxacin) has also been confirmed in patient testing[26]. Ethambutol and cycloserine can partially penetrate the blood-brain barrier under inflammatory conditions. When using these agents, caution is required regarding their optic neuritis toxicity and neurological toxicity, respectively[23,27].

The patient's condition progressed. Following a MDT consultation and in accordance with relevant guideline consensus, the final anti-tuberculosis regimen was determined as: isoniazid + rifampicin + linezolid + moxifloxacin combination therapy. It should be noted that ethambutol was not included due to the potential increased risk of post-choroidal neuritis in the fetus when combined with linezolid.

Tuberculosis during pregnancy refers to a group of diseases caused by newly acquired Mycobacterium tuberculosis infection during pregnancy or by pre-existing tuberculosis that has not been cured. Research has found that individuals who conceive through in vitro fertilization-embryo transfer (IVF-ET) technology exhibit a higher incidence of tuberculosis compared to those who conceive naturally[28]. The WHO recommends treating active tuberculosis during pregnancy with a four-drug first-line regimen (rifampicin, isoniazid, ethambutol, and pyrazinamide). Rifampicin, isoniazid, and pyrazinamide are known to induce hepatotoxicity[29]. In a cohort study of patients with tuberculosis following solid organ transplantation in Spain, fluoroquinolones and linezolid were demonstrated to be effective alternatives to isoniazid and rifampin[30]. However, it should be noted that quinolone antibiotics carry potential teratogenic risks and may affect fetal skeletal development. After thoroughly discussing the risks of anti-tuberculosis drugs to both the mother and fetus with the family, we collectively decided to prioritize the mother's life safety. Consequently, we opted for second-line intravenous anti-tuberculosis therapy while continuing pregnancy preservation measures. Liver and kidney function were monitored regularly during treatment. Following discharge, the patient transitioned to oral anti-tuberculosis drugs for maintenance therapy.

Due to the rarity of cases involving pregnancy complicated by multidrug-resistant tuberculosis worldwide, there is currently a lack of high-quality data from randomized controlled trials, cohort studies, or case-control studies. Therefore, this paper presents the application of a multidisciplinary collaboration model in the diagnosis and treatment of critically ill pregnant patients through a case report format. According to the 2022 meta-analysis published in China Pharmacy titled "Adverse Effects of Drug-Resistant Tuberculosis Treatment on Pregnant Women and Fetuses," exposure to drug-resistant tuberculosis treatment during pregnancy may lead to adverse outcomes such as maternal mortality, miscarriage, neonatal death, preterm birth, low birth weight, developmental delay, and stillbirth. However, the study did not observe any birth defects in newborns. These adverse outcomes may be associated with drug-resistant tuberculosis itself and the severity of the disease[31]V. It is therefore crucial to achieve early detection, diagnosis, and treatment of tuberculosis during pregnancy.

Declarations

Ethical Approval: The data collection in this study was conducted with the patients' explicit consent and following their signed informed consent forms (see supplementary materials), thus requiring no ethical review.

Consent for Publication

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Author Statement

We declare that this manuscript is original, has not been published before and is not currently being considered for publication elsewhere.

We confirm that the manuscript has been read and approved by all named authors and that there are no other persons who satisfied the criteria for authorship but are not listed. We further confirm that the order of authors listed in the manuscript has been approved by all of us.

We understand that the Corresponding Author is the sole contact for the Editorial process. She is responsible for communicating with the other authors about progress. submissions of revisions, and final approval of proofs.

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Figures

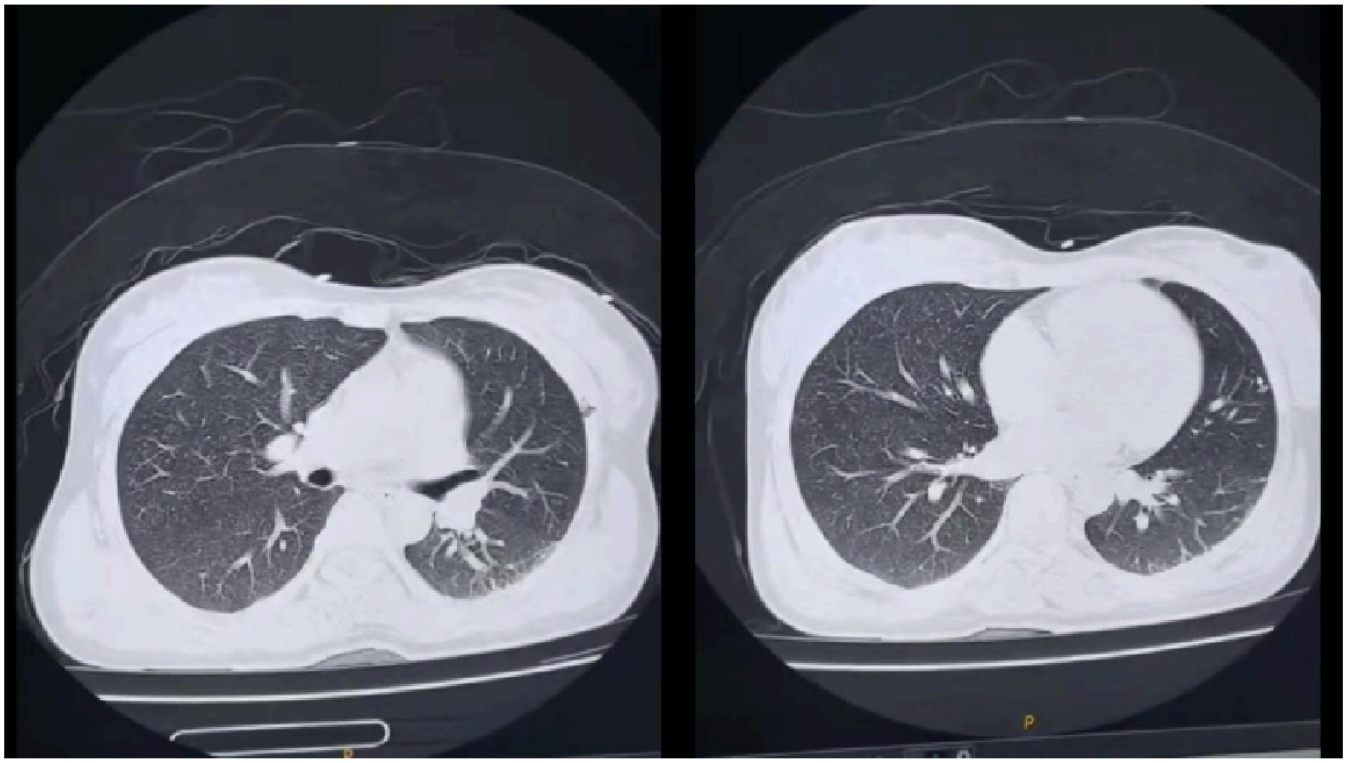


Figure 1

Chest CT Images of the Critically Ill Pregnant Patient (Miliary Tuberculosis)

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