

Recovery and Rehabilitation from Reactivation Tuberculosis and Resulting
Pneumonectomy: A Case Study

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Tuberculosis is a major global health concern, causing 1.7 million deaths worldwide per year and ranking only behind HIV as the second leading cause of deaths from infectious disease. The ability of the *Mycobacterium tuberculosis* bacteria to cause latent and silent infection has allowed it to spread to an estimated one-third of the world's population (Riley 2013). An ancient disease that has stalked humanity since the dawn of time, tuberculosis can be found in skeletons dating back to 4000 B.C. By 2000 B.C., the disease was prevalent in Egypt, India, and the Americas (Moore 2007).

Mycobacterium tuberculosis is a gram-positive, rod-shaped bacterium that is spread through droplets released by an infected person. The bacilli attack the alveolar macrophages, killing the cells inside. In response to the threat posed by tuberculosis, the macrophages attract additional immune responders such as neutrophils, monocytes, and other macrophages that wall off the infected area to produce a tubercle. If the immune system is incapable of containing the infection, cellular death in the alveoli leads to caseating necrotic lesions that can destroy the lung (Riley 2013).

The inhalation of *Mycobacterium tuberculosis* follows one of four paths. The first outcome is that the individual will immediately clear the organism from his or her lungs, resulting in no infection. The second outcome is a latent infection, which typically lies dormant unless the patient becomes immunocompromised. The third outcome is the onset of active TB, and the fourth - occurring in 5-10% of cases - is

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reactivation disease, which is the onset of active tuberculosis years after treatment or exposure (Riley 2013). While no single antibiotic will cure TB, the disease can be treated with a cocktail of several different antibiotics (Dyer 2010).

Tuberculosis is most prevalent in the developing world, thriving in areas where people live close together in unsanitary conditions with poor ventilation where the bacterium can be effectively spread (Moore 2007). The major risk factor for active disease is HIV, which destroys the immune system and leads to a fertile breeding ground for the bacilli. A large percentage of patients with HIV are also infected with TB, leading to a greater risk of death from complications than infection with either disease alone (Dyer 2010). This lethal combination of disease led the WHO to declare tuberculosis a global health emergency in 1993 (Moore 2007).

Reactivation of tuberculosis is caused by the proliferation of the mycobacterium following the resolution of the initial infection. Reactivation TB occurs in approximately 5-10% of otherwise healthy individuals with no underlying condition. It is unclear exactly what triggers the reactivation of the disease, although risk factors include HIV/AIDS, diabetes mellitus, malignant lymphoma, renal failure, and age. While primary TB can spread throughout the body, reactivation TB tends to remain localized, primarily attacking the apices of the lungs and causing lesions that can lead to massive pulmonary destruction (Riley 2013).

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While tuberculosis in the United States is still relatively rare, the incidence of TB in foreign-born persons has doubled from 1993 to 2009. A majority of these cases were reactivation tuberculosis. A few of the highest risk factors of reactivation TB in foreign-born persons were short time since immigration, short time since active disease, and TB incidence in the person's home country. Controlling tuberculosis, and its latent and reactivation manifestations, remains a major challenge to U.S. public health officials (Ricks 2011).

Patient Summary

Ms. X is a twenty-year-old recent immigrant from Surat, India in the western state of Gujarat. In 2010, she was diagnosed with tuberculosis following a positive sputum culture. She began therapy at a local clinic, but it is unclear what therapy she was on at that time. Ms. X presented to the clinic but often reported nausea and hid her pills so she would not have to take them. Due to worsening weight loss, her family took her to a private hospital where doctors suspected multi-drug resistant TB. She was placed on a cocktail of amikacin, levofloxacin, ethionamide, pyrazinamide, and para-amino salicylic acid for the next ten months. She regained some of her weight and was feeling better, according to her family; she also had three documented negative AFB sputums prior to immigration.

In March of 2013, Ms. X emigrated to Northern Virginia with her parents, staying with an uncle in Leesburg. She began to notice occasional blood-tinged sputum and dyspnea on exertion. In early July, she began to have a productive cough

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with clear sputum and was seen at an outpatient clinic on July 19, where she was prescribed moxifloxacin. After eight days of treatment, she began to have noticeable hemoptysis with fever, chills, and sweats. On July 28, she was admitted to Inova Loudoun Hospital in Leesburg, VA where she underwent a CT scan showing numerous cavitary lesions as large as 6 x 5 x 5cm. Her sputum tested negative for tuberculosis and she was started on meropenem with adjunct TB therapy to include rifampin, isoniazid, pyrazinamide, and ethambutol. As Ms. X had no health insurance, she was transferred to the University of Virginia for evaluation by thoracic surgery.

Ms. X arrived at UVA with tachycardia and significant hemoptysis of two tablespoons. Her white blood cell count was 14.4, showing signs of infection, and her hemoglobin was 9.1, indicating anemia from hemoptysis. She was promptly transferred to the Medical Intensive Care Unit, where her hemoptysis only worsened. An additional CT scan showed a near-destroyed left lung. On August 3, she coughed up 300 mL of bright red blood and was rushed down to Interventional Radiology for a left bronchial artery embolization. On August 5, she developed massive left-lung hemoptysis resulting in a total whiteout of her left upper and lower lobes. Interventional Radiology performed an additional embolization on her left internal mammary artery, but she bled heavily the next day. Despite placement of a 7.5 endotracheal tube into her right main stem, the MICU team had increasing difficulty ventilating and oxygenating the patient. Ms. X's clinical status worsened

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and she was rushed to the operating room for an emergent left-sided pneumonectomy, which she was given a 20% or less chance of surviving.

Following her pneumonectomy, Ms. X remained intubated and sedated in the MICU. She underwent multiple bronchoscopies to clear a large amount of secretions in her right upper lobe. Her chest tubes were removed a week later and the MICU team attempted to wean her off oxygen, but her recovery was complicated by an infection of *Streptotrophomonas maltophilia* pneumonia in her right lung. On August 16, she began to have symptoms of respiratory decompensation with hemodynamic changes; the MICU team administered epinephrine for emergency resuscitation and intubated her a second time. She was given a PICC line for an immediate course of IV Bactrim to treat her pneumonia. By late August, she had recovered enough for placement of a tracheotomy and PEG/J feeding tube, and was transferred to the Medical Surgical unit to begin her lengthy and tenuous recovery.

Ms. X presented to the Medical Surgical unit as a frail, wan, cachetic young woman who had been in the hospital for fifty days. At 5'2" and 79 lbs, she was suffering from malnutrition and deconditioning related to her long stay in the ICU during which she was heavily sedated and unable to eat. She had a tracheostomy tube in her throat and a PICC line in her upper left arm. She had a 2cm x 3cm open wound in her upper left back where her left lung had been removed. The wound was covered in Plurionics and was clean, dry, and intact, with minimal swelling and

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redness around the incision. She also had a PEG tube in her stomach for nutrition and hydration, as she had failed the swallow test.

While Ms. X was extremely weak and malnourished, her vital signs had improved greatly. Her blood pressure was 121/76, up from 87/53 on the day she was admitted to UVA Hospital. Her pulse was 95 and her temperature was 97.3 oral. Her respiratory rate was 20, within defined limits but on the high side due to her recent pneumonectomy and bacterial pneumonia. Her oxygen saturation was 100% and her laboratory values were within normal limits except for a creatinine of .5, slightly below the normal of .6 but not considered particularly troubling.

Despite being unable to speak due to her tracheotomy, Ms. X was alert and oriented to person, place and time. She was able to write notes to the staff in English on a piece of paper. She was on bed rest due to muscle weakness from fifty days of malnutrition, sedation, poor oxygenation, and blood loss. She suffered from bilious emesis due to tracheal suctioning of bronchial secretions, which triggered her gag reflex. She also had frequent episodes of watery diarrhea that were most likely caused by the high-calorie, high-protein Osmolite 1.5 that she received nocturnally.

Ms. X's recovery and rehabilitation regimen comprised an extensive combination of medications and treatments designed to improve her strength, nutrition, and lung capacity. She underwent Albuterol treatments with a nebulizer three times a day, after which copious bronchial secretions were suctioned from her

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tracheotomy. She was given Osmolite 1.5, fluids, and multivitamins through her PEG tube to help her gain weight. To improve lung capacity, she pedaled on a little machine with her hands and feet. As a bedridden patient, she was given prophylactic doses of heparin and Lovenox to prevent deep vein thrombosis. She was also prescribed famotidine and simethicone for gastrointestinal upset.

Pathophysiology

Reactivation tuberculosis typically occurs two years or more after primary infection with the bacilli. While primary TB often presents with a sudden high fever, the symptoms of reactivation TB are slower and more insidious. Patients report low-grade diurnal fevers with corresponding night sweats. Weight loss, dyspnea on exertion, chest pain, and fatigue are also common. Cough may be absent at first, but as the disease progresses it becomes productive with yellow-green sputum and, in severe cases, occasional hemoptysis. The symptoms of reactivation TB are so nonspecific that one-third of patients are diagnosed after hospitalization for unrelated complaints (Pozniak 2013).

In extremely rare and severe cases, reactivation tuberculosis can cause massive hemoptysis- estimated in under 5% of patients. This is caused by cavitary disease that causes lesions to rupture the pulmonary, bronchial, or intercostal arteries. Equally as rare is extensive pulmonary destruction, which usually results from multiple necrotic lesions that have turned into pulmonary gangrene,

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consolidating the lung. Patients with these types of advanced complications have an extremely high mortality rate estimated around 75% (Pozniak).

Medical Management

Reactivation tuberculosis is treated with first-line antibiotics unless multi-drug resistant TB is suspected. These drugs include isoniazid, rifampin, pyrazinamide, and ethambutol (Sterling 2013). Isoniazid is an antitubercular agent comprised of isonicotinic acid that interferes with bacterial cell wall synthesis. Rifampin is another antibiotic that works with a different mechanism of action, disrupting bacterial production of DNA to RNA. Pyrazinamide is an antituberculous agent that works well in acidic environments and is only used with isoniazid and rifampin. The above three are frequently used as a first-line cocktail. Ethambutol, a third antituberculous drug, works by inhibiting the production of ribonucleic acid in the mycobacterium and is often added with patients who have recently immigrated from areas where multi-drug resistant TB is common. As Ms. X had not completed her full treatment, there was no reason to suspect multi-drug resistant tuberculosis; however, she was from an area where tuberculosis is common, so ethambutol was added. She was also placed on meropenem, a carbapenem antibiotic (Micromedex). However, these medications were administered too late; CT scans already showed extensive destruction of her left lung, with multiple large cavitory lesions that were causing hemoptysis.

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Massive hemoptysis is a life-threatening medical emergency requiring immediate intervention. The first step is to determine location of the bleeding and position the patient in the dependent position of the lung. The second step is to establish an airway, typically by a single or double lumen large bore endotracheal tube. Ms. X had a 7.5 bore endotracheal tube placed while in the ICU. The third step is to assess cardiac function and mechanically ventilate the patient if he or she is hypercapnic. The fourth step is to immediately discontinue all anticoagulants that could be worsening the bleeding. If these methods do not stop the hemoptysis, the patient is typically treated with arterial embolization to locate and stop the bleeding directly at the source (Ingbar 2013). Ms. X underwent two arterial embolizations, on 8/3 and 8/5, but they failed to stop the bleeding due to the large nature of her cavitary lesions.

After the above methods have been exhausted in a patient with uncontrollable bleeding, surgical interventions are considered, such as an emergent pneumonectomy- the removal of an entire lung (Ingbar 2013). Surgical mortality for patients suffering massive hemoptysis is 20%, with morbidity ranging from 25-50% (Ingbar 2013). For patients specifically suffering from hemoptysis resulting from tuberculosis, the mortality rate is closer to 30% and possibly even higher in those undergoing a right-sided pneumonectomy, considered a higher operative risk (Kaiser 2007). Ms. X underwent an emergent left-sided pneumonectomy after she became increasingly tachypneic and hypoxemic due to inadequate gas exchange and

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persistent anemia. Before the procedure, her family was told that due to the severity of her disease, she did not have a high chance of surviving the operation.

Nursing Management

Nursing interventions are critical for the management of tuberculosis and the post-pneumonectomy patient. In the patient with acute reactive tuberculosis, massive hemoptysis can be initially treated with conservative nursing measures such as bed rest, posture changes, and intravenous fluids (Pozniak 2013). Ms. X benefited from excellent nursing care in the MICU, receiving fluids and laying on her left side so the bleeding wouldn't spread into her right lung. However, these measures failed to stop the bleeding- as did multiple arterial embolizations- and she was rushed to the operating room, where surgeons removed her entire left lung.

During her recovery in the Medical Surgical unit, the primary nursing diagnosis for Ms. X was risk for infection related to broken skin. The secondary nursing diagnosis was readiness for enhanced self-care. Lastly, the third nursing diagnosis was risk for bleeding in her remaining lung due to latent tuberculosis. These diagnoses were especially troubling given Ms. X's need for extensive rehabilitation, her dire financial situation, and her lack of health insurance.

Nosocomial infections with organisms such as MRSA, VRE, and *Clostridium difficile* are relatively common in hospitals; a multinational study of 17 ICUs revealed that 44.8% of patients had acquired a nosocomial infection. Pneumonia

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was the most common, with UTIs ranking second and bloodstream infections third (Irwin 2008). The mortality rate from nosocomial pneumonias outside of the ICU is approximately 36%; inside the ICU, the figure is much higher (Marti 2011).

Ms. X's primary diagnosis was risk for infection related to broken skin. She was extremely malnourished and weak; she had lost 14 lbs since her arrival at UVA and had a body mass index of 14, which is considered severely underweight. She had multiple entry locations for microorganisms including a 2 cm x 3cm open wound on her back, a PEG tube in her stomach, a PICC line in her arm, and a tracheostomy. Ms. X had already contracted one infection (*Stenotrophomonas maltophilia* bacterial pneumonia) while in the hospital that had severely weakened her respiratory capacity. Despite administration of high-calorie, high-protein Osmolite 1.5 and a daily multivitamin, she remained weak and frail.

The top nursing goal was to ensure that Ms. X remained free of any additional infections that could cause symptoms such as fever, erythema, tachypnea, or hypoxemia. Assessment interventions include monitoring the patient's white blood cell count, respiratory rate, temperature, and oxygen saturation. Action interventions include proper hand hygiene, sterile techniques when skin integrity is impaired, and ensuring the patient engages in regular pulmonary hygiene (Ackley 2011).

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Ms. X was frequently monitored for signs of infection throughout her stay on the Medical Surgical unit. Her vitals were taken every four hours by either a nurse or patient care assistant. Her labs were monitored for high white blood cell counts that could indicate infection. Her bandages were changed according to procedures governing sterility and infection prevention, and her wound was monitored for signs of infection such as pus or swelling. She was also encouraged to regularly practice pulmonary hygiene by suctioning bronchial secretions from her tracheotomy. Her PICC line was cleaned with alcohol solution before medications were administered and her tracheotomy tube was cleaned.

Patient and family education was especially critical for Ms. X, as she was due to be discharged into the care of her family, who would clean and care for her tracheotomy, PEG tube, and surgical wound. As her family spoke only minimal English, teaching proved to be difficult. Teaching interventions included basic tracheotomy care, sterile wound care, and care of the PEG tube.

The second nursing diagnosis for Ms. X was readiness for enhanced self-care. This diagnosis resulted from her frequent use of the rehabilitation pedaling machine to enhance her lung capacity and her willingness to take all her medications as prescribed. This differed from her previous status, in which she did not take her tuberculosis medications while living in India. Nursing interventions for this diagnosis include conducting demonstrations of self-care activities such as tracheal suctioning and providing literacy-appropriate education regarding self-care

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activities (Ackley 2011). While neither she nor her family were fluent in English, they seemed eager to learn about the basics of wound, tracheostomy, and PEG tube care. To ensure that she and her family understood how to care for her needs while preventing infection, the nursing staff asked the family to properly clean the tracheal tube and administer tube feedings. The family was able to complete these tasks in a sterile manner. Teaching interventions included explaining both the necessity and ease of self-care for the postsurgical patient; the goal was to make care of Ms. X's wound and tubes as doable and straightforward as possible, since she appeared ready to learn.

The third nursing diagnosis was risk for bleeding due to reactivation tuberculosis. Latent tuberculosis can be reactivated due to additional health conditions such as malignant lymphoma, corticosteroid use, diabetes mellitus, kidney failure, and advanced age (Riley 2013). While Ms. X's active tuberculosis was treated with two weeks of a rifampin/PZA/isoniazid cocktail, the disease could reactivate due to an underlying condition. This would put her at risk for bleeding caused by lesions in the lungs; as stated before, reactivation tuberculosis is typically confined to the lungs. However, it very rarely causes complications such as massive hemoptysis, and Ms. X's chances of again experiencing massive hemoptysis with resulting pneumonectomy were no greater than that of any other patient.

Nursing interventions for this goal include monitoring vital signs for tachypnea or low oxygen saturation, checking all medications for possible

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anticoagulant properties, and monitoring laboratory values such as prothrombin time, international normalized ratio, and partialized thromboplastin time. Abnormal values on the PT, INR, or PTT tests could indicate a subtle bleeding problem. Other assessment measures including assessing the patient for signs of bleeding such as frank hemoptysis (Ackley 2011). Ms. X's laboratory values for PT, INR, PTT, hemoglobin, and hematocrit were closely monitored for signs of additional bleeding; heparin therapy would have been discontinued if she had shown signs of internal bleeding or additional blood in her sputum. Her vitals were checked at least every four hours and recorded in the electronic medical record to track possible trends.

Teaching interventions for this goal included educating the patient and her family about monitoring for signs of anemia, such as pallor and fatigue, and educating about the necessity of emergency medical treatment if her hemoptysis returned. Ms. X and her family received extensive teaching about the risk of reactivation tuberculosis and concurrent bleeding, especially since she now only had one lung. Ms. X also received education on the importance of following through with the complete regimen of antibiotic therapy in order to properly treat tuberculosis and prevent recurrence.

Conclusion

Ms. X was released from UVA Hospital after a stay totaling over fifty days. She was discharged into the care of her family and is reportedly gaining weight and strength while remaining free of infection. Despite her dire economic status, she was

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fortunately able to receive home health care to assist with care of her tracheostomy, wound, and feeding tube. While not all the nursing diagnoses were met prior to discharge- there is no real way to prevent some of the conditions that could cause reactivation of tuberculosis- Ms. X was discharged with the confidence that in time, all the goals would be met with success. This was due to her positive attitude and eagerness to learn enhanced self-care techniques while recovering from her illness and resulting surgery. Among the nurses on her Medical Surgical unit, she is considered a survivor and a true success story.

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