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Optimized Physiotherapy Management for Enhancing Respiratory and Physical Functions in a Complex Case of Fungal Pneumonia, Systemic Lupus Erythematosus, Lupus Nephritis, and Acute Kidney Injury: A Case Report

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ABSTRACT

Introduction: Fungal pneumonia is a lung infection caused by endemic or opportunistic fungi. It is common in immunocompromised hosts with systemic lupus erythematosus (SLE) due to immunosuppressive agents and high doses of glucocorticoid treatment.
Case Description and Method: We report a case of a 14-year-old female with complaints of coughing, breathlessness, pedal edema, vomiting, and diarrhea. Initial diagnoses were SLE, lupus nephritis (LN), and acute kidney injury (AKI). She was intubated due to not maintaining oxygen saturation. A Chest X-ray showed consolidation and mild pleural effusion. Diagnosis of fungal pneumonia was confirmed by bronchoalveolar lavage. Adventitious sounds, reduced air entry in different areas of the lungs, and reduced chest expansion were found. Chest physiotherapy and passive limb exercises were given. After extubation, other examinations included modified Medical Research Council (mMRC: grade 4), borg scale (15) during limb movements, Cough Symptom Score (CSS: 4) and Functional Status Score for Intensive Care Unit (FSS-ICU: 8) was noted. 6 MWT (220 meters) was taken after the patient shifted to the ward. Respiratory physiotherapy with early mobilization and aerobic exercises were applied.
Results: Chest X-ray, chest expansion, mMRC (grade 1), borg scale (9) during limb movements, CSS (2), incentive spirometer (1200 cc/sec), FSS-ICU (35/35), and 6 MWT (310 meters) were improved after physiotherapy interventions.
Conclusion: Tailored physiotherapy inputs improve the pulmonary and physical functions of patient with fungal pneumonia, systemic lupus erythematosus, lupus nephritis, and acute kidney injury.

Keywords: physiotherapy, fungal pneumonia, respiratory, physical function, systemic lupus erythematosus, acute kidney injury

INTRODUCTION

Pneumonia is an acute respiratory disease. It is defined as a lower respiratory tract infection caused by microorganisms in lung parenchyma, particularly in the alveolar space. [1,2] It is one of the restrictive lung diseases. Pneumonia is classified based on location, pattern of involvement, and etiology, according to the American Thoracic Society (ATS). Based on the area of infection, there are 3 types: Community-Acquired pneumonia (CAP), Hospital-Acquired Pneumonia (HAP), and Ventilator-Associated Pneumonia (VAP). It is divided into lobar, lobular, and diffuse interstitial pneumonia based on the pattern of involvement. According to causative microorganisms, pneumonia is classified as bacterial, viral, fungal, and parasitic pneumonia. Pneumonia consists of 4 stages: congestion, red hepatization, grey hepatization, and resolution.[2] Common symptoms include dyspnea, coughing with or without sputum production, chest pain, fever, rigor, myalgia, and confusion.[1]

Fungal organisms rarely cause pneumonia in the general population. [3,4] Different fungi causing pneumonia are Aspergillus spp., Candida spp., Cryptococcus neoformans, Coccidioides immitus, Histoplasma capsulatum, Blastomyces dermatitidis, and Pneumocystis. Most frequently caused by Aspergillus spp., Cryptococcus neoformans, and Dimorphic fungi. The incidence of fungal pneumonia is higher in immunocompromised hosts. [4,5]

Systemic Lupus Erythematosus (SLE) is a systemic autoimmune disorder affecting multiple organ systems, including the kidney, lung, skin, heart, hematopoietic system, and brain. The prevalence of SLE is higher in females than males. Kidneys are affected in about 50% of patients with SLE.[6] Chronic inflammation in the kidney due to SLE is known as Lupus Nephritis (LN). Severe persistent proteinuria in glomerulonephritis leads to Acute Kidney Injury (AKI) and End Stage Renal Disease (ESRD). [7,8]

Physiotherapy in the form of early pulmonary and physical rehabilitation from the ICU is important in improving a patient's respiratory function, peripheral muscle strength, and daily activities and preventing secondary complications.[9]

CASE REPORT

We report a case of a 14-year-old female, a known case of SLE (diagnosed 2 years ago), who had complaints of fever, vomiting, diarrhea, malar rash, oral ulcer, joint pain, bilateral pedal edema, coughing, and breathlessness during rest for 2-3 days. She was admitted to a tertiary care hospital for 15 days, where she was diagnosed with LN and AKI. She was treated with corticosteroids, but symptoms persisted. Then, she was referred to the Institute of Kidney Disease and Research Centre for further management.

On admission, she was conscious (GCS-15) but not maintaining saturation on room air (SPO2: 76%-80%). Then she kept on NRBM (O_2 Flow: 15L/ min) for 2 days, and saturation improved to 99%. Her general condition went poor suddenly on the 3rd day. She started gasping and not maintaining oxygen saturation. Then she was intubated and kept on PRVC mode via an endotracheal tube with FiO_2: 70% and PEEP: 8 cmH2O. She had a previous medical history of pneumonia (2 years ago, ICU admission on NRBM) and pulmonary tuberculosis (1 year ago, AKT taken for 6 months).

At the time of the initial encounter with the patient, she was intubated on PRVC mode of mechanical ventilator. The blood report showed reduced hemoglobin, RBC count, and platelet count. The ABG report showed partially compensated respiratory acidosis. Aspergillus antigen (Galactomannan) was positive. HRCT scan of the thorax showed a large area of parenchymal consolidation with an air bronchogram and a thick-walled cavity formation involving the right middle lobe, multiple tiny nodular densities in both lung fields, mild traction bronchiectatic

changes in bilateral lower lobes, and fibrocalcific opacities in the left upper lobe. These changes suggested infective etiology-likely Koch's. The chest X-ray showed homogenous opacity on the right middle and lower zones. Costophrenic and cardiophrenic angles were blunted on the right side. These changes suggested pleural effusion with consolidation in the right middle and lower lobes. BAL report showed candida albicans infection in the lung, which confirmed the diagnosis of fungal pneumonia. She was on medication antibiotics, antifungal, antiviral, antirheumatic, anticonvulsants, corticosteroids, proton pump inhibitors, loop diuretics, and bronchodilators. Additionally, hemodialysis also started.

Her breathing pattern was shallow tachypneic abdomino-thoracic breathing. On auscultation, air entry was reduced in the middle and lower lobes of the right lung. Coarse crackles were present in the middle and lower lobes of the right lung, and wheezes were present in the upper lobe of the left lung. There was a dull note on percussion in the right middle and lower zones with cardiac dullness. Chest excursion was reduced in the right lower zone. Upper and lower thoracic expansion was reduced, but more reduction was seen in lower thoracic expansion. According to the initial assessment, physiotherapy treatment was given.

On the 12th day of admission, she was extubated and kept on an O_2 mask with 5 L/min oxygen flow. After extubating, the patient had chief complaints of breathlessness during limb exercises and coughing. On auscultation, fine crackles and wheezes were still present. Other assessments taken that included RPE on Borg scale: 15 (hard) during active limb ROM exercises, mMRC grade: 4 (too breathless to leave the house or breathless when dressing or undressing), Cough Symptom Score (CSS: 4 -frequent coughing during daytime which did interfere with usual day time activities and frequent coughs most of the night) and Functional Status Score in ICU (FSS- ICU: 8). On the 14th day, KOH preparation of sputum yielded no fungal elements.

On the 20th day, she was shifted to the ward. As soon as the patient was shifted to the ward and started walking independently, we took a submaximal exercise test: 6 Minute Walk Test (6MWT) to assess exercise capacity. Her 6 Minute Walk Distance (6 MWD) was 220 metres. So, tailored physiotherapy treatment is given to improve the respiratory and physical function of patients. She was discharged on the 29th day. Home advice for exercises was given.

MATERIALS & METHODS

According to regular assessment, physiotherapy treatment is given. Physiotherapy management was divided into 3 phases: (1) During intubation in the ICU: Chest physiotherapy is given to clear the airway and consolidation, improve chest expansion, and prevent further accumulation of secretion. Passive limb exercises were given to maintain the ROM of joints and prevent contracture. (2) After extubation in ICU to step down ICU: In addition to previous treatment, further management focused on dyspnea management, bronchial clearance, improving inspiratory capacity, and early mobilization. (3) In-ward: Treatment focused on improving cardiovascular endurance and making the patient independent in her daily activities. Further home advice was given to maintain and improve physical and respiratory function.

Table 1: Summary of Interventions

<table>
<tr><th>Time and Place</th><th>Goals</th><th colspan="4">Intervention</th></tr>
<tr><td rowspan="3">During Intubation in ICU
(3rd day-11th day)</td><td>Airway clearance</td><td colspan="4">1. Nebulization:
• NS (0.9% NS or 3% NS)
• Mucolytic
• Bronchodilators
2. Postural Drainage position
3. Chest manual and mechanical vibration
4. Endotracheal Suction</td></tr>
<tr><td>To improve epigastric excursion and lung compliance</td><td colspan="4">Chest PNF:
• Intercostal Stretch
• Anterior stretch and basal lift
• Manual maintained pressure</td></tr>
<tr><td>To maintain the mobility of joints</td><td colspan="4">Passive ROM exercises of shoulder, elbow, wrist, fingers, hip, knee, ankle, and toes.</td></tr>
<tr><td rowspan="5">After Extubation in ICU to Step Down ICU
(12th day-19th day)</td><td>To reduce dyspnea</td><td colspan="4">1. Dyspnea-relieving positions
2. Pursed lip breathing
3. Relaxed Diaphragmatic Breathing Exercise
4. Breathing control
5. Activity pacing
6. Energy conservation techniques</td></tr>
<tr><td rowspan="2">Airway clearance</td><td colspan="4">In addition to previous interventions for airway clearance</td></tr>
<tr><td colspan="4">1. After the resolution of the fever, manual percussion was added.
2. Active Cycle of Breathing Technique (ACBT)</td></tr>
<tr><td>To improve chest expansion and inspiratory capacity</td><td colspan="4">1. Segmental Breathing Exercise
2. Thoracic Expansion Exercises
3. Incentive spirometry</td></tr>
<tr><td>To improve bed mobility</td><td colspan="4">1. Active assisted ROM exercises progressed to active ROM exercises
2. Functional re-education:
• Alternate position changing and rolling
• Long sitting
• Supine to high-sitting
• High-sitting to standing
• Sit to stand
• Spot marching
• Bedside walking with support to walking without support</td></tr>
<tr><td rowspan="6">In Ward
(20th day-29th day)</td><td colspan="5">In addition to previous interventions given during the post-extubation phase in step-down ICU</td></tr>
<tr><td rowspan="6">To improve exercise capacity</td><td colspan="4">Aerobic exercise training</td></tr>
<tr><td>Frequency</td><td colspan="3">6 days/week, 2 times/day</td></tr>
<tr><td>Phases</td><td>Warm Up</td><td>Exercise Period</td><td>Cool Down</td></tr>
<tr><td>Intensity</td><td>RPE: 8-9 (very light exertion) according to the Borg scale</td><td>Moderate intensity RPE: 12-14 (somewhat hard exertion) according to the Borg scale</td><td>RPE: 8-9 (very light exertion) according to the Borg scale</td></tr>
<tr><td>Time</td><td>5 minutes</td><td>15-30 minutes</td><td>5 minutes</td></tr>
<tr><td>Type</td><td>Active upper and lower limb exercises (repetitions: 10)</td><td>Walking: minimum 7-10 mins, then progressed to 15-20 mins.
Stair climbing and down initiated: minimum 10 steps, then progressed to 15- 25 steps.</td><td>Stretching of major muscles: gastrocnemius, soleus, and hamstrings</td></tr>
</table>

Home Advice	To maintain and improve respiratory and physical function	Continue breathing exercises, ACBT, incentive spirometry, limb exercises, walking, and stair climbing. Dyspnea-relieving positions and activity pacing had been taught to her.
During treatment and exercise, vitals and signs of hypotension and dyspnea were monitored.		

Figure 1: ACBT with Nebulization

Figure 2: Incentive Spirometry

Figure 3: Dyspnea Relieving Position

Figure 4: Spot Marching

Figure 5: Aerobic Training

Figure 6: Dyspnea Relieving Position in standing

RESULT

After an initial assessment, the patient was reassessed after extubation, in the ward, and on discharge. Progressive improvement was seen in all outcomes. Upper and lower thoracic expansion improved from 2 cm to 3

cm and 1.2 cm to 2.7 cm, respectively, till discharge. Post extubation, the dyspnea score (mMRC) significantly reduced from grade 4 to 1. RPE during active limb movements (Borg score) reduced from 15 to 6. CSS reduced from 4 to 2. The capacity of the incentive spirometer increased from 600 to 1200 cc/sec. FSS-ICU improved from 8 to 35 score. 6 MWT- distance significantly increased from 220 meters to 310 meters on discharge. Radiological findings were also improved.

Table 2: Summary of improvement in outcomes

	Post Intubation	Post Extubation	In Ward	On Discharge
Upper Thoracic Expansion (cm)	2	2	2.6	3
Lower Thoracic Expansion (cm)	1.2	1.4	2	2.7
mMRC	-	4	2	1
RPE During Active Limb Movements (Borg Score)	-	15	10	6
CSS	-	4	3	2
Incentive Spirometer (cc/sec)	-	600	900	1200
FSS- ICU	-	8	35	35
6 MWD (metre)	-	-	220	310

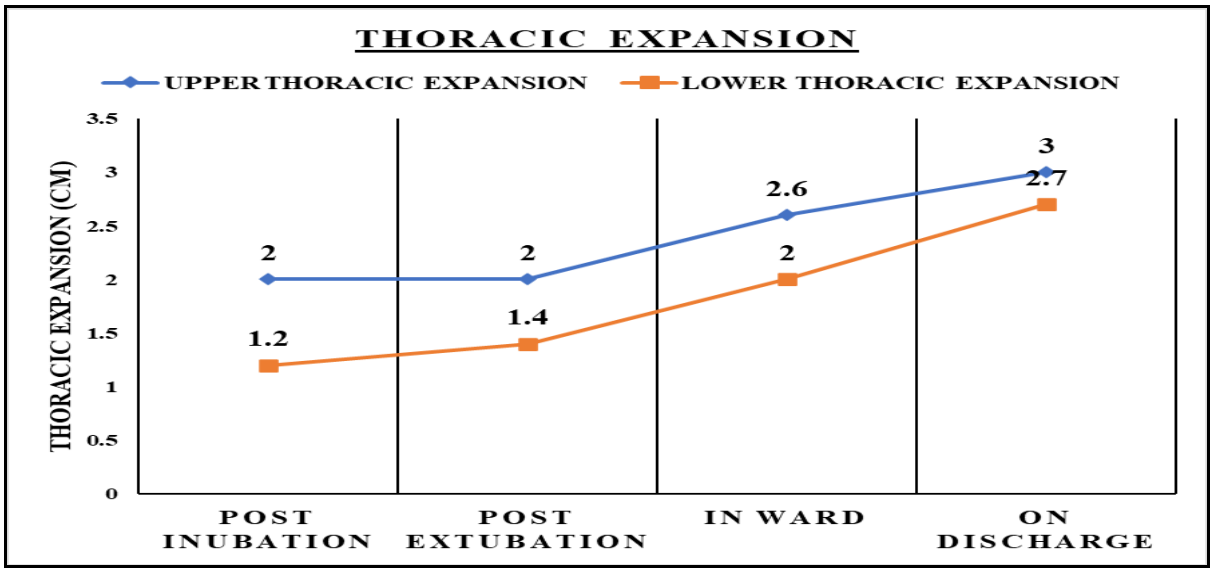

Figure 7: Graph illustrating the progression of the thoracic expansion

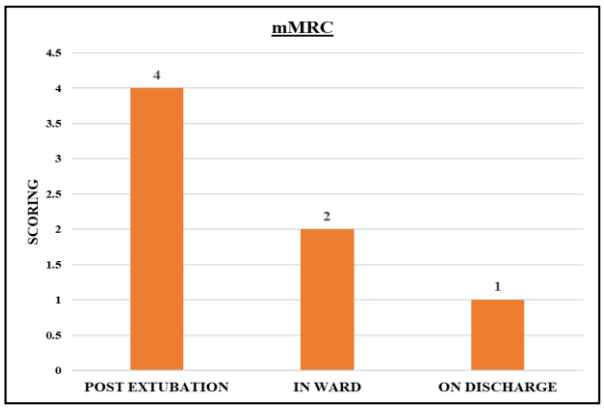

Figure 8: Graph illustrating the progression of the mMRC

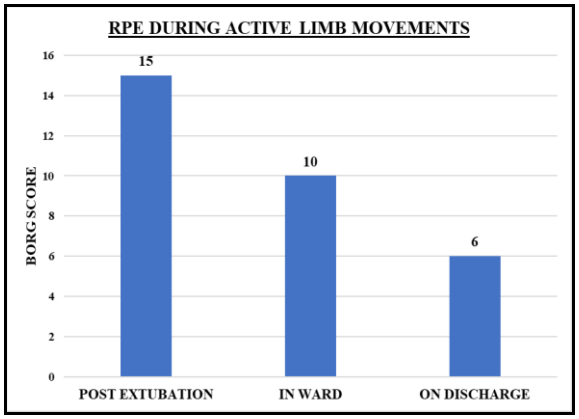

Figure 9: Graph illustrating the progression of RPE

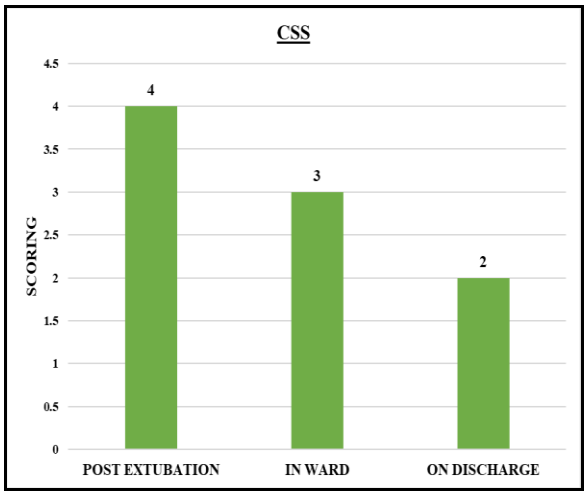

Figure 10: Graph illustrating the progression of CSS

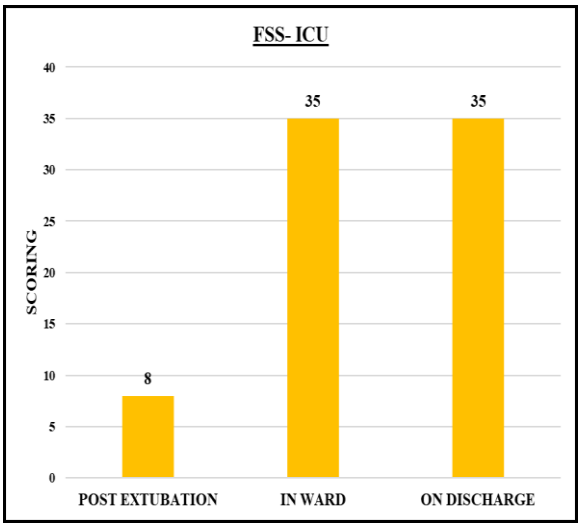

Figure 12: Graph illustrating the progression of FSS-ICU

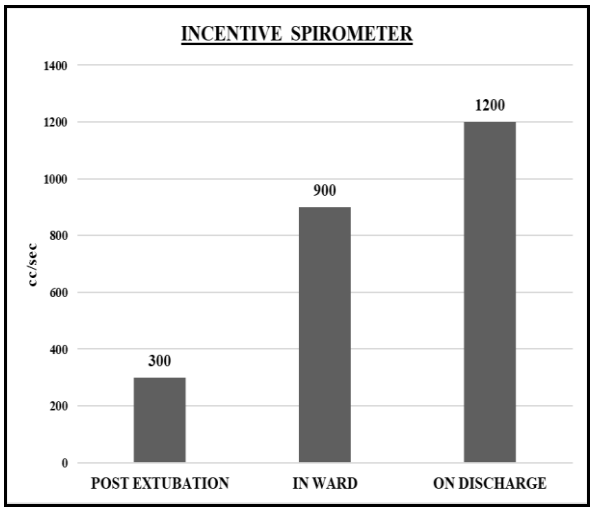

Figure 11: Graph illustrating the progression of the Incentive Spirometer

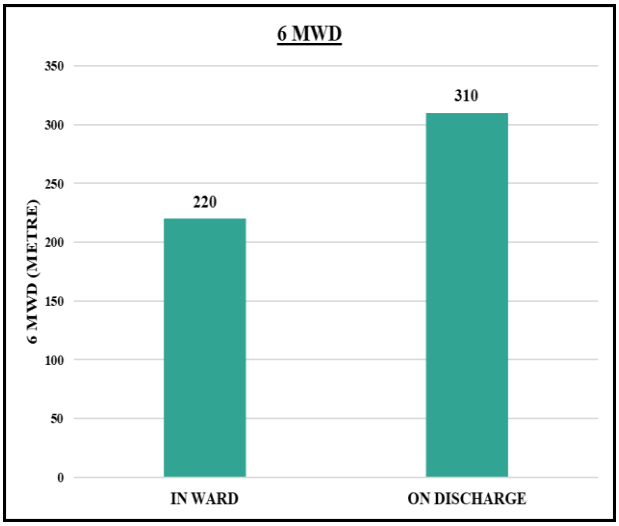

Figure 13: Graph illustrating the progression of 6-MWT

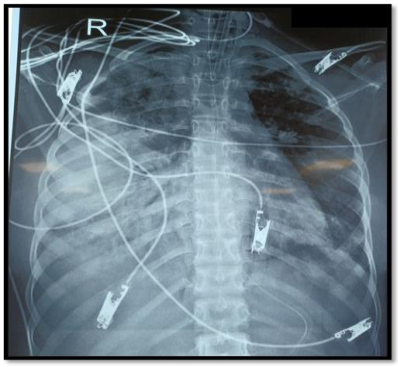

Figure 14: Chest X-ray showing marked consolidation in the right middle and lower lobes (1st Day)

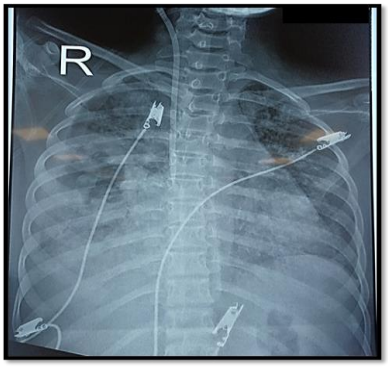

Figure 15: Chest X-ray showing some reduction in consolidation and cavity formation in the right middle lobe (12th Day)

Figure 16: Chest X-ray showing marked reduction in consolidation and resolution of pneumonia (23rd Day)

DISCUSSION

Active lupus, Lupus Nephritis (LN), and renal insufficiency are major risk factors for developing pneumonia in SLE, in which pneumonia is one of the main causes of morbidity and mortality. Fungal pneumonia is common in immunocompromised hosts with SLE due to immunosuppressive agents and high doses of glucocorticoid treatment.[10] There are many risk factors for immunocompromised like AIDS, cancer, chemotherapy, anemia, asplenia, neutropenia, biological drug use, solid organ transplantation, chronic steroid use, and solid tumor. According to a secondary analysis of the Global Initiative for Meticillin-Resistant Staphylococcus Aureus Pneumonia (GLIMP) database, chronic steroid use is the most prevalent risk factor present in 45% of immunocompromised patients.[11]

Critical illness can cause ICU admission and lead to ICU-acquired weakness. This is more common in patients with sepsis, multiple organ failure, pneumonia, and prolonged mechanical ventilation. Prolonged physical inactivity leads to a reduction in muscle mass and strength. This affects the muscles of the limbs and respiration prominently. It is known that only 10-14 days of bed rest leads to significant loss of lower limb muscle mass and strength, an increase in visceral fat, and a reduction in insulin sensitivity.[12] The use of oral corticosteroids in the management of dyspnea and fatigue, high circulating levels of cytokines, and oxidant/antioxidant imbalance in patients with pneumonia can also adversely affect functional capacity and muscle strength.[13]

There are relapsing and remitting phases in the SLE course. From different studies, it is estimated that 20–25% of SLE patients will experience a relapse phase within 1–2 years and 40–66% within 5–10 years after remission status. 70%-80% of the exacerbations are of mild or moderate severity and 20%–30% are of severe class. Patients with SLE who experience exacerbations are at risk of developing irreversible dysfunction and damage to end organs.[14] Studies showed that cardiopulmonary endurance (lower anaerobic threshold, maximum heart rate, maximum minute ventilation, reduced resting lung function measures, mainly forced vital capacity, and VO2 max) and isometric muscle strength are reduced in SLE patients than healthy individuals of the same age group due to corticosteroid use which induce muscle atrophy of both type I and type II muscle fibers. This will lead to fatigue and inactivity. To address these domains, both aerobic exercise and resistance exercise are beneficial in SLE patients with low to moderate disease activity. Although the risk of adverse events is less, studies showed significant differences between SLE patients and controls in heart rate at rest, blood pressure response to standing, lower adrenaline, and plasma noradrenaline levels. Due to this, they may have difficulties making maximal efforts, such as maximum repetitions and prolonged aerobic exercise. To prevent adverse events, a supervised exercise program is needed in this population. [15,16]

A systematic review and meta-analysis were done by Lee et al. on the efficacy of respiratory physiotherapy interventions for mechanically ventilated adults with pneumonia. They have incorporated positioning, gravity-assisted drainage, percussion, chest wall vibrations, manual hyperinflation, ventilator hyperinflation, and expiratory rib cage compression (ERCC). They showed significant improvement in secretion clearance (sputum wet weight), static lung compliance, and tidal volume.[17] Zhao et al. did an RCT on the effect of pulmonary rehabilitation on patients' outcomes after extubation and showed a beneficial effect on improving diaphragm strength, peripheral muscle strength and endurance, and activities of daily living. In addition, it reduces the use of non-invasive ventilation and re-intubation rate.[9]

Studies showed positive effects of chest physiotherapy with early mobilization on reducing the duration of mechanical ventilation, re-intubation rate, rapid shallow breathing index, delirium, improvement in muscle power, and lung compliance in mechanically ventilated patients with pneumonia.[18,19] As there is very little literature found on physiotherapy in fungal pneumonia, so in line with these studies we have applied respiratory physiotherapy, early mobilization, and aerobic exercise in our patient. They were safe and beneficial to improving thoracic expansion, dyspnea score, RPE, CSS, incentive spirometer, FSS-ICU, aerobic capacity, and radiological findings. There were no adverse events during treatment.

There are conflicting studies that do not support the importance and use of physiotherapy in pneumonia patients, and very less studies are available on physiotherapy in fungal pneumonia. So, as it is a single case study, it will limit the generalizability of its results. To solve this issue, a randomized control trial with a larger population is needed to prove the effects of physiotherapy in fungal pneumonia.

CONCLUSION

The findings of this case study showed that tailored physiotherapy inputs along with medical management have positive effects on thoracic expansion, dyspnea, rate of perceived exertion, coughing, incentive spirometry, functional status, aerobic capacity, and radiological findings of the patient. These results emphasize physiotherapy as an essential part of a multidisciplinary approach to improve the respiratory and physical function of patients with fungal pneumonia along with systemic lupus erythematosus, lupus nephritis, and acute kidney injury.

Declaration by Authors

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Conflict of Interest: The authors declare no conflict of interest.

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