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[CASE STUDY]

Physiotherapy Management To Improve Lung Function In Diabetic Ketoacidosis: A Case Study

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ABSTRACT

Background: Type 1 Diabetes Mellitus (T1DM) can lead to diabetic ketoacidosis (DKA), a dangerous consequence that frequently causes severe metabolic abnormalities, respiratory distress, and neuromuscular dysfunction. Physiotherapy is essential for treating the respiratory and functional deficits linked to DKA, even if medical care is also crucial. The objective of this case study is to demonstrate the significance and efficacy of physical therapy treatments in enhancing lung function and the patient's overall recuperation in cases of DKA.

Case Presentation: A male patient, age 22, who had a history of type 1 diabetes, came in with chronic coughing, dyspnoea, and widespread weakness. DKA was verified by clinical and radiological evidence, and two days after admission, physiotherapy was started. Breathing exercises, airway clearance procedures, gradual ambulation, and endurance training were all part of the patient's organised rehabilitation program.

Results: From an initial SpO_2 of 92% to 99–100%, the physiotherapy routine resulted in significant improvements in respiratory parameters, chest expansion, and oxygen saturation levels. The patient showed increased muscular strength, endurance, and functional ability as they moved from restricted mobility to independent ambulation.

Conclusion: In patients with DKA, early physiotherapy intervention greatly improves respiratory function, avoids complications, and speeds up functional recovery. For the best patient results, this instance emphasises the need for an integrated multidisciplinary strategy that combines medical and physiotherapy care.

Keywords: *Diabetic ketoacidosis, respiration, Respiratory physiotherapy.*

Introduction :

Diabetic Ketoacidosis (DKA) is a severe and acute complication of diabetes mellitus that predominantly affects individuals with Type 1 Diabetes Mellitus (T1DM). This condition arises when there is a critical absence or insufficiency of insulin, which leads to elevated blood sugar levels (hyperglycemia), the presence of ketones in the blood and urine (ketosis), and a state of metabolic acidosis.[1] DKA can escalate quickly and, if not treated promptly, can result in life-threatening complications. Patients presenting with DKA often experience a combination of symptoms that may include significant dehydration, electrolyte imbalances, respiratory distress, and neuromuscular dysfunction. These symptoms not only pose immediate health risks but also have lasting effects on the patient's physical health, emotional well-being, and functional capabilities.[1]

Physiotherapy emerges as a crucial and indispensable component in the multidisciplinary management of patients suffering from DKA. It plays a vital role in mitigating the various complications associated with this condition. Specifically, physiotherapy effectively addresses respiratory complications, which are common given the metabolic disturbances associated with DKA. Techniques such as breathing exercises, airway

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clearance methods, and chest physiotherapy can significantly improve lung function and respiratory efficiency. Furthermore, these interventions support patients in recovering from general weakness and deconditioning that often results from prolonged illness and immobility, enhancing their overall physical strength and endurance.[3]

This case report focuses on the physiotherapy assessment and intervention applied to a 22-year-old male diagnosed with DKA. Upon presentation, the patient exhibited marked breathlessness, persistent coughing, reduced pulmonary function, and generalized weakness, compounded by decreased mobility. These presenting symptoms highlighted the urgent need for a comprehensive physiotherapy approach tailored to the patient's specific condition.

Case Presentation :

We describe a 22-year-old man who was taken to the hospital after complaining of eight days of dyspnoea, four days of a persistent cough, and eight days of polyuria. After missing his previous two insulin doses, he began experiencing dyspnoea, fever, and nausea eight days earlier. He then went to the hospital for tests, including an X-ray, blood work, urine testing, and an arterial blood gas analysis. He was subsequently diagnosed with DKA. He was receiving regular insulin therapy after receiving a Type 1 Diabetes Mellitus (T1DM) diagnosis two years prior. There was no record of any prior DKA incidents in his past. A one-year history of diabetes mellitus in his mother points to a possible genetic vulnerability to metabolic diseases.

Upon physical examination, the patient weighed 48 kg and measured 165 cm in height, yielding a BMI of 17.6 kg/m², making them underweight. His being underweight raised the possibility of low functional ability, decreased exercise tolerance, and muscular atrophy.

Clinical findings :

Table no. 1 : Generalized overview :

Patient was concious and oriented to time, place and person	
Built:	Ectomorphic
Attitude of Patient	Patient was in sitting position Arms by his side And hands resting on knees
Posture:	In standing Frontal view- neck-shoulder angle on the right side is reduced Lateral view- forward head - Kyphosis Posterior view- increased scapulo-thoracic distance B/L
External Appliances-	IV line

Table mo. 2 : Systematic overview :

Neck :

Tracheal position	Central
Tracheal Tugging	Present
Use of accessory muscle	Present
Trail sign	No present

Table no. 3 :Thorax:

• Thoracic configuration (shape)-Chest Deformities:-	• Symmetrical Transverse diameter >Anteroposterior diameter
• Movement of chest- I. Respiratory Rate II. Rhythm- III. Breathing Pattern- IV. Chest Expansion	 33 Regular Thoracoabdominal Equal B/L
• Inspiration:Expiration Ratio-	2:1.5

Table no. 4 :Extremities :

Clubbing	Grade 1
Weakness and wasting	Generalised weakness
Autonomic skin changes	Dry feet
Nicotine stains	Absent
Pedal oedema	Absent
A wound on the index finger	1.5 cm in length

Table no. 5 :Palpation :

Odema	Absent
Tracheal Position	Central
Capillary perfusion	3 sec.
Position of apex beat	5th intercostal space
Movement of Chest	Equal B/L
Chest Expansion of Tape At Infraaxillary At 5th intercostal space At Xiphistenal	 2 cm 3.5 cm 3.5 cm
Tactile vocal Fremitus	Equal on Both sides
Percussion	Resonant on Both sides

Auscultation :

Air entry is reduced on the Right side with Crepitations present on the right middle zone

On cardiovascular examination, no murmur was appreciated.

S1 and S2 is heard

Investigations :

1. ABG Analysis: done on 18th oct 2024 shows metabolic acidosis with

PH- 6.985

PCO2-5.1 mmHg

PO2- 130.9%

HCO3-1.2 mmol/L

2. X-ray Analysis : done on 19th Oct 2024 shows

It was taken in AP view

During inspiration

Ground glass opacities are present on the lateral part of the right lung

The costophrenic angle is blunted on the right side

Table no. 6 :Outcome measures :

Measure	Predicted	Performed	Percentage reduction
PEFR	489	300	29%

Timeline Table:
Date of Admission: 18/10/2024
Date of Physiotherapy Rehabilitation: 20/10/2024
Date of Discharge: 26/10/2024

Table no. 7 :Therapeutic Intervention:

DAY	MANAGEMENT		VITALS	
	Medical Management	Physiotherapy Management	Pre-Vitals	Post-Vitals
PT Day 1 Morning Evening	NBM IVF 1st 3 Hrs – 3 L Next 6 Hrs – 3 L Next 15 Hrs – 3 L Inj KCL via Infusion Inj HAI via Infusion Pan 40 IV	Patient Education Breathing Exercises 1) Diaphragmatic breathing *10 rep 2 sets 2) Pursed lip breathing *10 rep 2 set left lateral positioning * 30 min Ankle toe movement * 10 rep *B/L Heel slides *10 rep* B/L	HR= 90bpm SpO_2 =92% HR= bpm SpO_2 =96%	HR= 93bpm SpO_2 =95% HR= bpm SpO_2 =98%
PT Day 2 Morning Evening	Liquid diet IVF 250 ML / hr Inj KCL via Infusion Inj HAI via Infusion Pan 40 IV Tb Pan SOS Neb With Duoline And Budecort	Breathing Exercises 1) Diaphragmatic breathing *10 rep 2 sets 2) Pursed lip breathing *10 rep 2 set 3) ACBT * 2 cycles Dynamic Quads *10 rep *B/L Ankle Toe Movements *10rep* B/L Ambulation * bed side	HR= bpm SpO_2 =96% HR= bpm SpO_2 =96%	HR= bpm SpO_2 =98% HR= bpm SpO_2 =99%
PT Day 3 Morning Evening	IVF 250 ML / hr Inj KCL via Infusion Inj HAI via Infusion Pan 40 IV Inj monocef Neb With Duoline And Budecort	Breathing Exercises 1) Diaphragmatic breathing *10 rep 2 sets 2 Pursed lip breathing *10 rep 2 set 2 Incentive spirometry *10 rep 4) ACBT * 2 cycles Dynamic Quads *10 rep *B/L Ankle Toe Movements *10rep* B/L Ambulation with pursed lip breathing * 2 lap	HR= bpm SpO_2 =97% HR= bpm SpO_2 =99%	HR= bpm SpO_2 =99% HR= bpm SpO_2 =99%
PT Day 4 Morning Evening	Inj HAI via Infusion Pan 40 IV Inj monocef Neb With Duoline And Budecort Tb PCM 650 mg Syp Brozedex 5 ml	Breathing Exercises 1) Diaphragmatic breathing *10 rep 2 sets 2 Pursed lip breathing *10 rep 2 set 2 Incentive spirometry *10 rep	HR= bpm SpO_2 =99%	HR= bpm SpO_2 =99%

	Tab mucinac 600 mg	4) ACBT * 2 cycles Dynamic Quads *10 rep *B/L Ankle Toe Movements *10rep* B/L Ambulation with pursed lip breathing * 2 lap	HR= bpm SpO_2 =99%	HR= bpm SpO_2 =99%
PT Day 5 Morning Evening	Inj HAI via Infusion Pan 40 IV Inj monocef Neb With Duoline And Budecort Tb PCM 650 mg Syp Brozedex 5 ml Tab Mucinac 600 mg	Breathing Exercises 5) Diaphragmatic breathing *10 rep 2 sets 6 Pursed lip breathing *10 rep 2 set 6 Incentive spirometry *10 rep 8) ACBT * 2 cycles Dynamic Quads *10 rep *B/L Ankle Toe Movements *10rep* B/L Ambulation with pursed lip breathing * 2 lap Cycle ergometry * 5 min.	HR= bpm SpO_2 =99%	HR= bpm SpO_2 =100%
			HR= bpm SpO_2 =99%	HR= bpm SpO_2 =99%

Discussion:

Hyperglycemia, ketosis, and metabolic acidosis are the hallmarks of diabetic ketoacidosis (DKA), a potentially fatal consequence of type 1 diabetes mellitus (T1DM). Respiratory distress, electrolyte abnormalities, dehydration, and neuromuscular dysfunction are common in DKA patients, and these conditions have a substantial negative influence on their physical well-being and capacity to operate.[1] In this case study, a 22-year-old man with DKA who had dyspnoea, a chronic cough, decreased pulmonary function, and widespread weakness is managed with physical therapy. In order to promote overall recovery, physiotherapy's main goals were to restore lung function, increase airway clearance, avoid deconditioning, and enable early mobilisation.

Kussmaul's respiration, or deep, laboured breathing, is a compensatory mechanism for respiratory impairment brought on by metabolic acidosis, which is one of the main concerns in DKA. The right middle zone's crepitations indicated mucus retention, which might worsen ventilation and oxygenation. The necessity for treatments to maximise lung function was further supported by the initial SpO_2 of 92%, which suggested moderate hypoxaemia.[2] In order to improve ventilation and lessen respiratory discomfort, breathing exercises are essential. In order to promote gas exchange, lower respiratory effort, and improve alveolar ventilation, diaphragmatic breathing and pursed-lip breathing were first used. Later, in order to promote lung expansion and avoid atelectasis, incentive spirometry was used.[3] Furthermore, the Active Cycle of Breathing Techniques (ACBT) were used to assist airway clearing and mobilise secretions, lowering the risk of pulmonary problems.[4] Another crucial technique to enhance ventilation and oxygenation was positioning. By improving ventilation-perfusion matching, left lateral placement lessened respiratory effort and encouraged efficient secretion clearance. Together, these tactics improved oxygenation, as seen by the steady rise in SpO_2 from 92% to 99–100% after therapy.[5]

DKA causes muscular atrophy, decreased exercise tolerance, and widespread weakness in addition to metabolic abnormalities and extended hospitalisation. The patient's underweight BMI of 17.6 kg/m² significantly raised his risk of muscular atrophy and diminished functional ability. In order to keep circulation going, avoid deconditioning, and encourage general recuperation, early mobilisation was crucial.[6] Physiotherapy methods concentrate on strengthening exercises and gradual mobilisation to address these issues. In order to avoid deep vein

thrombosis (DVT) and venous stasis, passive and active activities such heel slides and ankle-toe exercises were offered in the first few days. Dynamic quadriceps workouts were added once the patient's health stabilised in order to preserve lower limb strength and stamina. In order to provide adequate oxygenation during movement, ambulation started at the bedside and was progressively advanced to walking with pursed lip breathing. Later phases of rehabilitation included five minutes of cycle ergometry, which increased endurance and cardiopulmonary fitness.[4] In addition to improving the patient's strength and mobility, these progressive workouts improved circulation and avoided the problems that come with extended immobility, such contractures, pressure sores, and a decline in functional independence.[6]

Both physical endurance and respiratory function significantly improved as a result of the planned physiotherapy method. The patient's oxygen saturation increased, airway clearance improved, and dyspnoea gradually decreased. Tests of pulmonary function showed improved air admission, increased chest expansion, and a return to normal breathing patterns. Functionally, the patient showed increased muscle strength, endurance, and general well-being as they moved from limited mobility to independent ambulation.

Conclusion:

Beyond just providing medical stabilisation, physiotherapy is essential for maximising respiratory function, averting problems, and encouraging a speedy recovery in patients with DKA. This example emphasises how crucial progressive mobilisation, posture tactics, breathing exercises, and airway clearance treatments are to enhancing a DKA patient's functional results. A good recovery and thorough patient care require a multidisciplinary approach that combines medical and rehabilitation techniques.

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