CHARLES UNIVESITY
Faculty of Physical Education and Sports

BACHELOR THESIS

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CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORTS
Physiotherapy Department

Case study of a patient with pneumonia after COVID-19 disease

Bachelor Thesis

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Prague, May 2021

Declaration

I declare that this thesis has been written by myself, based on the clinical work placement. The writing was done according to the theoretical and practical knowledge that I have gained during my studies at the Faculty of Sport and Physical Education in Charles University.

I declare that no invasive methods where used during the clinical work placement in Institut Klinicke a Experimentalni Mediciny and the patient was informed about the procedures.

In Prague, May 2021 **Ekaterina Trashchenko**

Acknowledgments

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Finally, thanks to Christine for her faith in me and support, we got through all together. Also thanks to my friends during studies Silia and Maie for their support and help.

Abstract

Author: Ekaterina Trashchenko

Title: Case study of a patient with pneumonia after COVID-19 disease

Objectives: This thesis is divided into two general parts. The first one consists of overviewing the anatomy of the respiratory system, the background of pneumonia, and coronavirus. The second part presents the case study, with respective examinations provided, treatments and results after providing all the therapies.

Methods: All examinations and treatments are based on the knowledge I have acquired in the Faculty of Physical Education and Sports of Charles University. These include examination of the breathing pattern, goniometry, muscle length test, anthropometric measurements, neurological examination, fascia examination, examination of the muscle tone, joint play examination and mobilization, soft tissue techniques, respiratory physiotherapy, muscle stretching, and passive movements adapted the patient's need. The goals of the therapies are to improve lung ventilation, relaxation of the overused muscles, correct the breathing pattern and prevent future complications given by immobilization.

Results: The patient underwent ten therapies, where after the muscle relaxation techniques the significant improvement was noticed, the lung ventilation improved right after the respiratory therapy was applied, ROM in all joints of the upper and lower extremities was maintained or improved. However, due to the severe lung damage given by pneumonia and COVID-19, the patient passed away after two weeks from the beginning of the therapy.

Conclusion: The therapies were effective to solve the limitations and restrictions found during the initial kinesiological examination. Concerning respiratory therapy, it was effective mostly right after the therapy was applied and during the first week working

with the patient. Physiotherapy couldn't affect the general state of the patient due to severe lung damage and the critical state of the patient.

Keywords: Physiotherapy, Coronavirus disease, pneumonia, respiration, lungs

Abstrakt

Autor: Ekaterina Trashchenko

Název: Kazuistika pacienta s pneumonií po prodělaném onemocnění COVID-19

Cíl: Tato práce je rozdělena do dvou obecných částí. První část obsahuje přehled anatomie dýchacího systému, pozadí pneumonie a koronaviru. Druhá část zahrnuje případovou studii s poskytnutými příslušnými vyšetřeními, léčbami a výsledky po poskytnutí všech terapií.

Metody: Všechna vyšetření a ošetření vycházejí ze znalostí, které jsem získala na Fakultě tělesné výchovy a sportu Univerzity Karlovy. Patří mezi ně vyšetření dechového vzorce, goniometrie, test svalové délky, antropometrická měření, neurologické vyšetření, vyšetření fascie, vyšetření svalového tonusu, vyšetření a mobilizace kloubů, techniky měkkých tkání, dechová fyzioterapie, protahování svalů a pasivní pohyby přizpůsobené potřebám pacienta. Cílem terapií je zlepšit plicní ventilaci, uvolnění nadužívaných svalů, napravit dechový stereotyp a zabránit budoucím komplikacím způsobeným imobilizací.

Výsledky: Pacientka podstoupila deset terapií, kde po technikách svalové relaxace došlo k výraznému zlepšení, ventilace plic se zlepšila ihned po aplikaci respirační terapie, ROM ve všech kloubech horních a dolních končetin byl udržen nebo zlepšen. Kvůli závažnému poškození plic způsobenému pneumonií a COVID-19, pacientka zemřela po dvou týdnech od začátku léčby.

Závěr: Terapie byly účinné při řešení omezení zjištěných při počátečním kineziologickém vyšetření. Pokud jde konkrétně o respirační terapii, byla účinná většinou ihned po aplikaci, už během prvního týdne práce s pacientem. Fyzioterapie

nemohla ovlivnit celkový stav pacientky kvůli vážnému poškození plic a jeji kritickému stavu.

Klíčová slova: Fyzioterapie, Koronavirus, pneumonie, dýchání, plíce

Table of content

1. Introduction

The clinical work placement took place at Institut Klinicke a Experimentalni Mediciny (IKEM), started on Monday 18th of January 2021 and ended on Friday 12th of February 2021 with a total of 120 hours.

I was working with 75 years old female diagnosed with Pneumonia, recovering after coronavirus disease (COVID-19). I selected this patient because of my interest in respiratory diseases, in addition to this topic of coronavirus is now being discussed all around the world.

The first part of the thesis contains the theoretical part of the respiratory system, its anatomy, and physiology, information about the respiratory muscles, pneumonia, its classification, medical and physiotherapeutic treatment. It also presents the problem of COVID-19, its pathogenesis, and pathology, how it affects various organs of the human body, as well as physiotherapy and drug treatment, depending on the stage of the disease.

The second part is practical, transcript of the examinations and daily therapies applied to the patient in IKEM during the work placement. All therapeutic procedures and exercising are explained.

2.Theoretical part

2.1 Anatomy

2.1.1 Respiratory system

The human respiratory system is a set of organs and tissues that provide the exchange of gases between the blood and the external environment in the human body. The respiratory system consists of the organs involved in breathing: nose, pharynx, larynx, trachea, bronchi, and lungs. The respiratory system is divided into two sections: the upper airways and the lower airways. The upper respiratory tract includes the nose, nasal cavity, maxillary sinus, frontal sinuses, larynx, and trachea. The lower respiratory tract includes the lungs, alveoli, and bronchi.(1)

The airways consist of tubes, the lumen of which is preserved due to the presence of a bone or cartilaginous skeleton in their walls. This morphological feature is fully consistent with the function of the respiratory tract - carrying air into the lungs and out of the lungs. The inner surface of the respiratory tract is covered with a mucous membrane, which is lined with ciliated epithelium, contains a significant number of mucus-secreting glands. Thanks to this, it performs a protective function. Passing through the respiratory tract, the air is purified, warmed, disinfected, and humidified. In the process of evolution, on the way of the air stream, the larynx was formed - a complex organ that performs the function of voice formation. Through the respiratory tract, air enters the lungs, which are the main organs of the respiratory system. In the lungs, gas exchange occurs between air and blood by diffusion of gases (oxygen and carbon dioxide) through the walls of the pulmonary alveoli and adjacent blood capillaries. (1; 10)

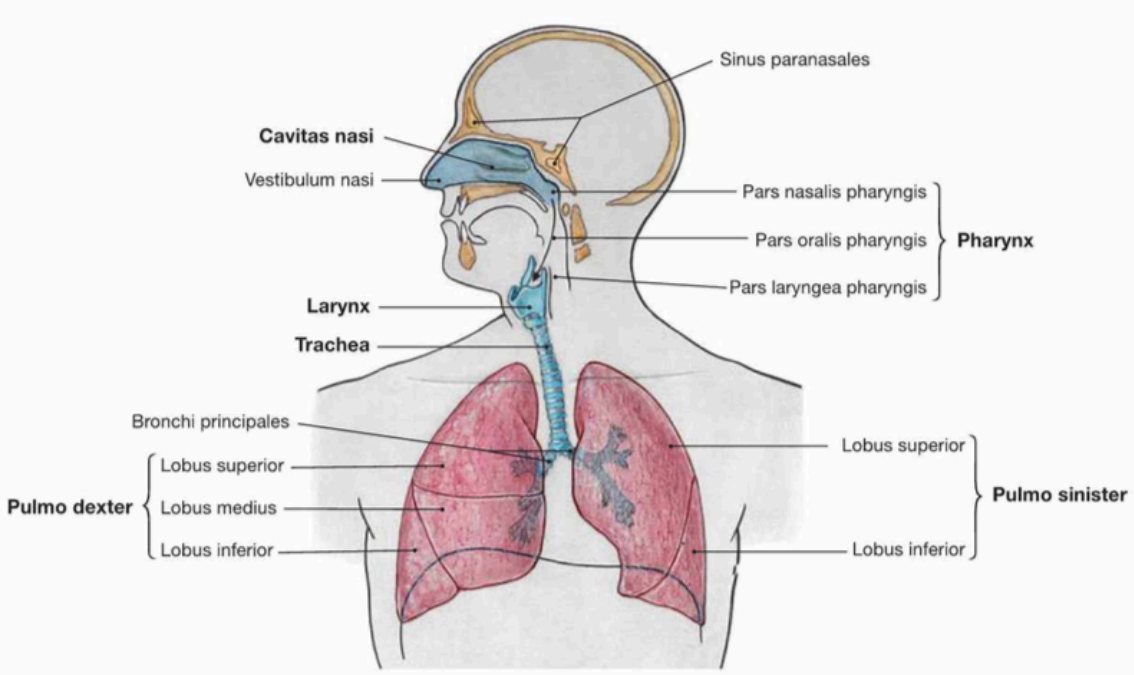

Figure 1: Upper and lower respiratory tract; schematic illustration. (4)

2.1.1.1 Nasal cavity and nasopharynx

The nasal cavity consists of several passages, divided by a nasal septum into left and right parts. There are three turbinates- the upper, middle and lower, they are formed by folds of the lateral shell hanging down into the nasal cavity. Between the shells are the nasal passages - the upper, middle and lower, in which the paranasal sinuses, or sinuses of the nose open. In the lower nasal undercarriage, the nasolacrimal canal opens, in the middle - the maxillary and frontal sinuses and the anterior cells of the ethmoid bone, and in the upper - sphenoid sinuses. (1)

The inner surface of the nasal cavity is lined with ciliated epithelium, which secretes mucus, moisturizing the incoming air and retaining dust. The mucus contains substances that destroy microorganisms. Cilia expel mucus containing dust particles and microorganisms from the nasal cavity. In the walls of the nasal cavity, there is a dense network of capillaries, the arterial blood flowing in them warms the inhaled air. The mucous membrane of the nasal cavity contains many immune cells - phagocytes,

lymphocytes, as well as immune complexes - antibodies. The mucous membrane at the back of the nasal cavity contains the olfactory cells that sense odors. Thus, the nasal cavity performs important functions: warming, moisturizing, and purifying the air, as well as protecting the body from harmful influences through the air.(1)

2.1.1.2 Pharynx

The pharynx is a tube that connects the oral and nasal cavity with the larynx and esophagus. It begins at the base of the skull and ends at the inferior border of the cricoid cartilage. The pharynx consists of three parts: nasopharynx, oropharynx, and laryngopharynx.(1)

2.1.1.3 Larynx

The larynx is a wide, short tube of cartilage and soft tissue. It is located in the anterior part of the neck and can be palpated from the front and sides through the skin. From above, the larynx passes into the laryngeal part of the pharynx, from below it passes into the trachea. Adjacent to the larynx is large cervical vessels and nerves, behind - the lower part of the pharynx, passing into the esophagus. The larynx is involved in respiratory, protective, vocal, and speech functions. (10)

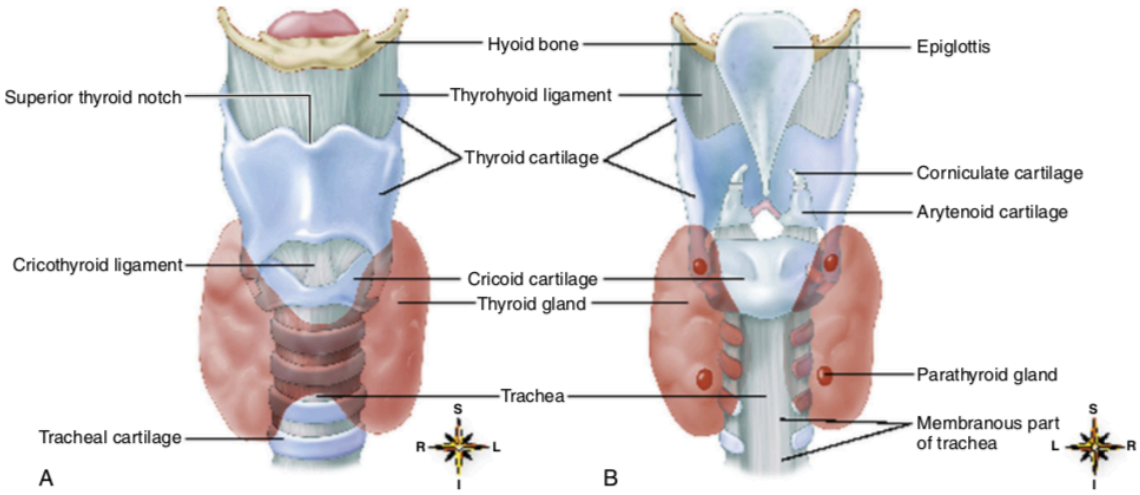

Figure 2 : Anatomy of the larynx. A, Anterior view. B, Posterior view (9).

2.1.1.4 Trachea and bronchi

The trachea begins at the level of the VI-VII cervical vertebrae, its a tube of 16-20 cartilaginous hyaline semirings connected by annular ligaments. The length of the trachea is 10-15 cm, it distinguishes between the cervical and chest parts. At the level of the V thoracic vertebra, the trachea is divided into two main bronchi, leading the airflow to the left and right lungs. The right bronchus is shorter and somewhat wider than the left, it departs from the trachea at an obtuse angle. (1;9)

Bronchi represent the passageways leading into the lungs. The main bronchi are the widest, they enter the lung. After entering the lungs, the bronchi continue to branch further into the secondary bronchi, which then branch into tertiary bronchi. Segmental bronchi continue their branching until they reach the final, sixth generation of bronchi. Every generation, starting from primary, is supported by cartilage in its wall. After the sixth generation, the passageways are very narrow to be supported by the cartilage and called bronchioles, that end in alveoli. (1;9)

When the main bronchi form the bronchial tree, each branch of this tree is

responsible for a small, limited part of the lung - a segment. Smaller branches of the bronchi, pass into the alveoli, in which oxygen and carbon dioxide are exchanged. (1)

The mucous membrane of the trachea and bronchi is lined with ciliated epithelium. The cilia can move in waves from the lungs outward. Small particles caught on the mucous membrane are enveloped in mucus and are pushed out of the body when a person cough or sneezes. (7)

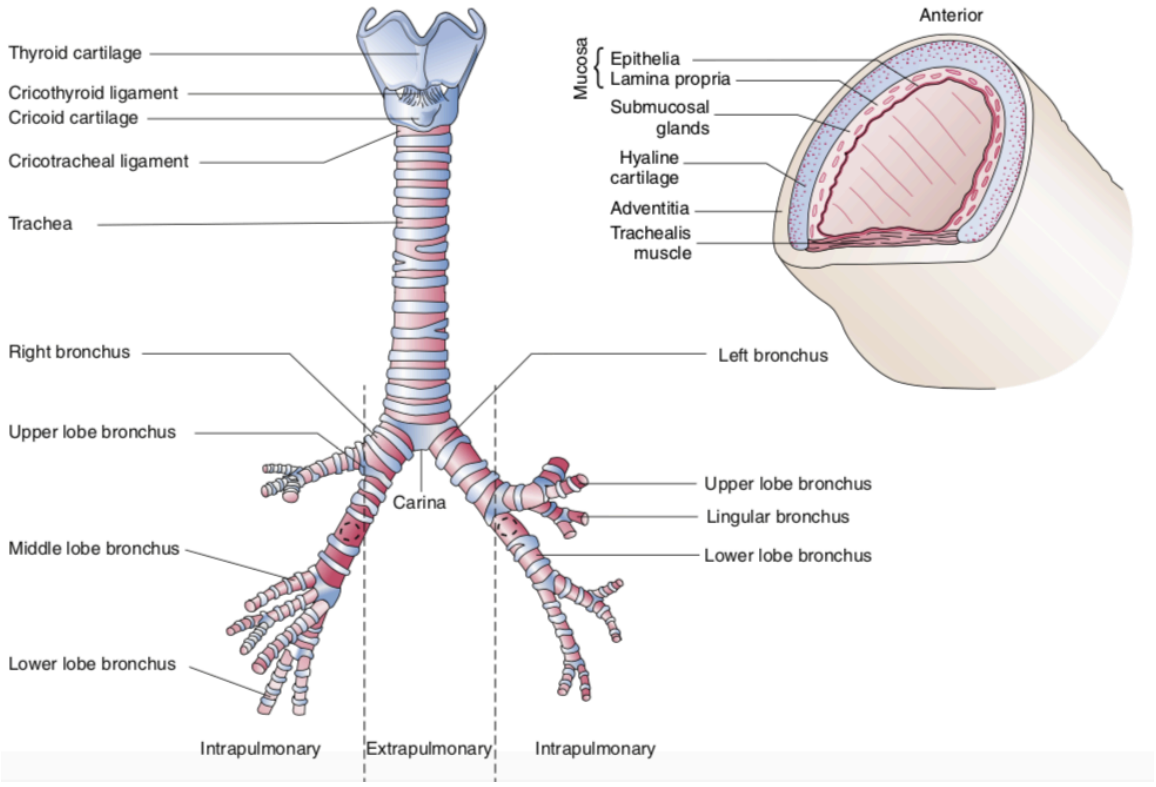

Figure 3: The trachea and mainstem, lobar, and segmental bronchi.(9)

2.1.1.5 Lungs

The lungs are a soft, spongy, cone-shaped paired organ that occupies almost the entire cavity of the chest, and is the main organ of the respiratory system. The lungs exchange carbon dioxide and oxygen. Their size and shape are variable and can change depending on the phase of breathing. There are no muscles in the lungs, so they cannot expand and contract on their own, but their structure allows breathing movements performed by the intercostal muscles and the diaphragm. (7)

Each lung is truncated cone-shaped. The outer convex surface of the lungs is adjacent to the ribs, from the inner side they include the main bronchi, pulmonary artery, pulmonary veins, and nerves, which form the root of the lungs. The right lung is wider and shorter. In the lower anterior edge of the left lung, there is a depression to which the heart is attached. On the concave surface of the lungs, there is a depression, in this place the pulmonary and bronchial arteries, bronchi, and nerves enter the lungs and the pulmonary and bronchial veins, as well as lymphatic vessels. The capillaries that are found in abundance in the lungs are responsible for gaseous exchange. (7;9)

The lungs are made up of the lobes of the lungs. By deep grooves, the right lung is divided into three lobes. Among them, the upper lobe, the middle lobe, and the lower lobe are distinguished, and the left lobe is divided into two: the upper and lower. The lungs are divided into the costal surface, the diaphragmatic surface, and the medial surface, in which the vertebral part, mediastinal, and cardiac indentation are isolated. (9)

The lower (diaphragmatic) surface of the lungs adjacent to the diaphragm is concave. The lateral surfaces of the lungs (costal) are adjacent to the ribs, on the medial (mediastinal) surface of the left lung there are cardiac notch corresponding to the heart. (9)

Since the lungs are the internal environment of the body, which are constantly used for the external environment, they have an adapted and special structure not only for gas exchange but also for protection - various inhaled infectious pathogens, dust, and smoke are retained and excreted in the respiratory tract. (16)

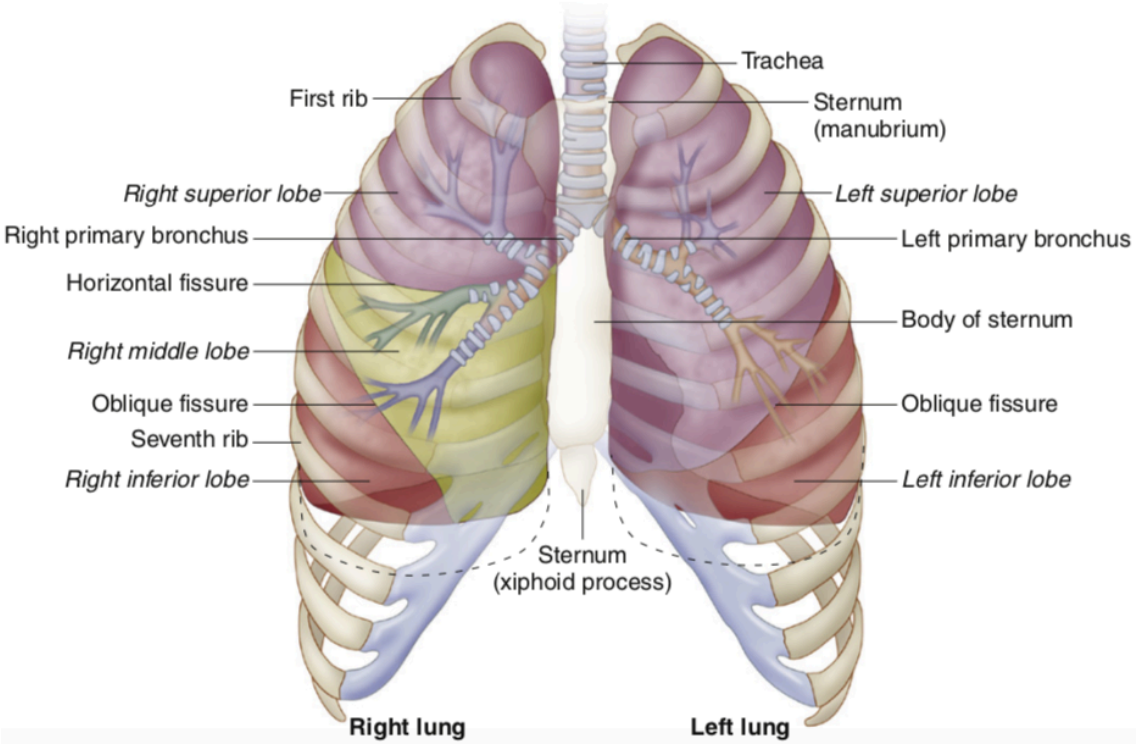

Figure 4: Lobes and segments of the lungs. (9)

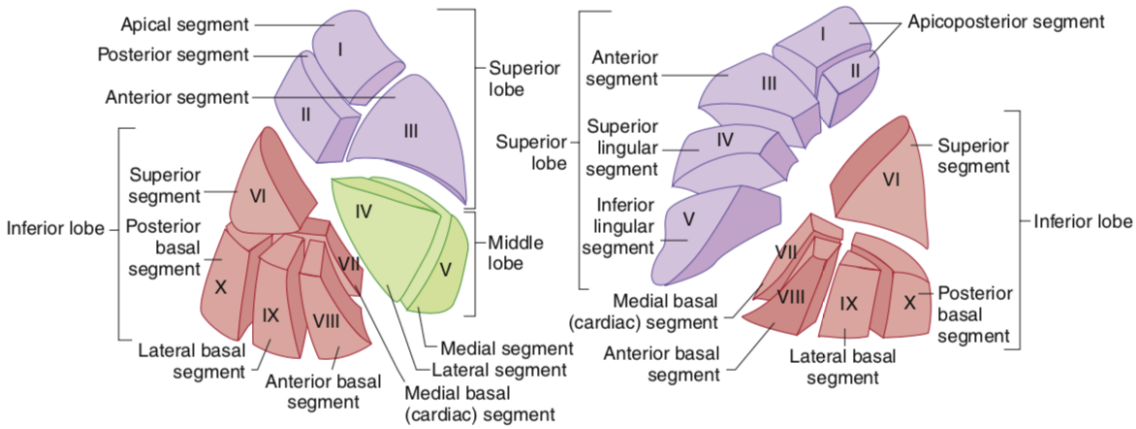

Figure 5: Lobes and segments of the lungs. (9)

2.1.1.6 Lung function

The main function of the lungs is gas exchange between the lungs and the blood. The alveolar and pulmonary capillary gases equilibrate across the thin blood-air barrier. This thin membrane is folded into alveoli, providing a large surface area for gas exchange to occur. (22)

The intake of oxygen-saturated air into the lungs and the removal of exhaled, carbon-dioxide-saturated air outward are provided by active respiratory movements of the chest wall and diaphragm and the contractility of the lung itself in combination with the activity of the respiratory tract. It happens because the lungs are not capable of expanding to breathe on their own, and will only do so when there is an increase in the volume of the thoracic cavity. (22)

At the same time, the diaphragm and the lower parts of the chest have a great influence on the contractile activity and ventilation of the lower lobes, while ventilation and changes in the volume of the upper lobes are carried out mainly with the help of movements of the upper chest. (22)

2.2 Respiratory muscles

Respiratory muscles form a complex structure that forces air into the lungs. The inspiratory muscles expand the chest cavity and work during inhalation, while the expiratory muscles compressing the chest cavity facilitate exhalation. The peculiarity of these muscles is that they are created from fatigue-resistant muscle fibers and are controlled by both voluntary and involuntary mechanisms.(23;29)

The main inspiratory muscles are the diaphragm and the external intercostal muscles. Normal relaxed exhalation is a passive process due to elastic contraction of the lungs and surface tension. However, there are several muscles that help in the forced exhalation, including the internal intercostals, innermost intercostals, subcostals, quadratus lumborum, and abdominal muscles. (23;30)

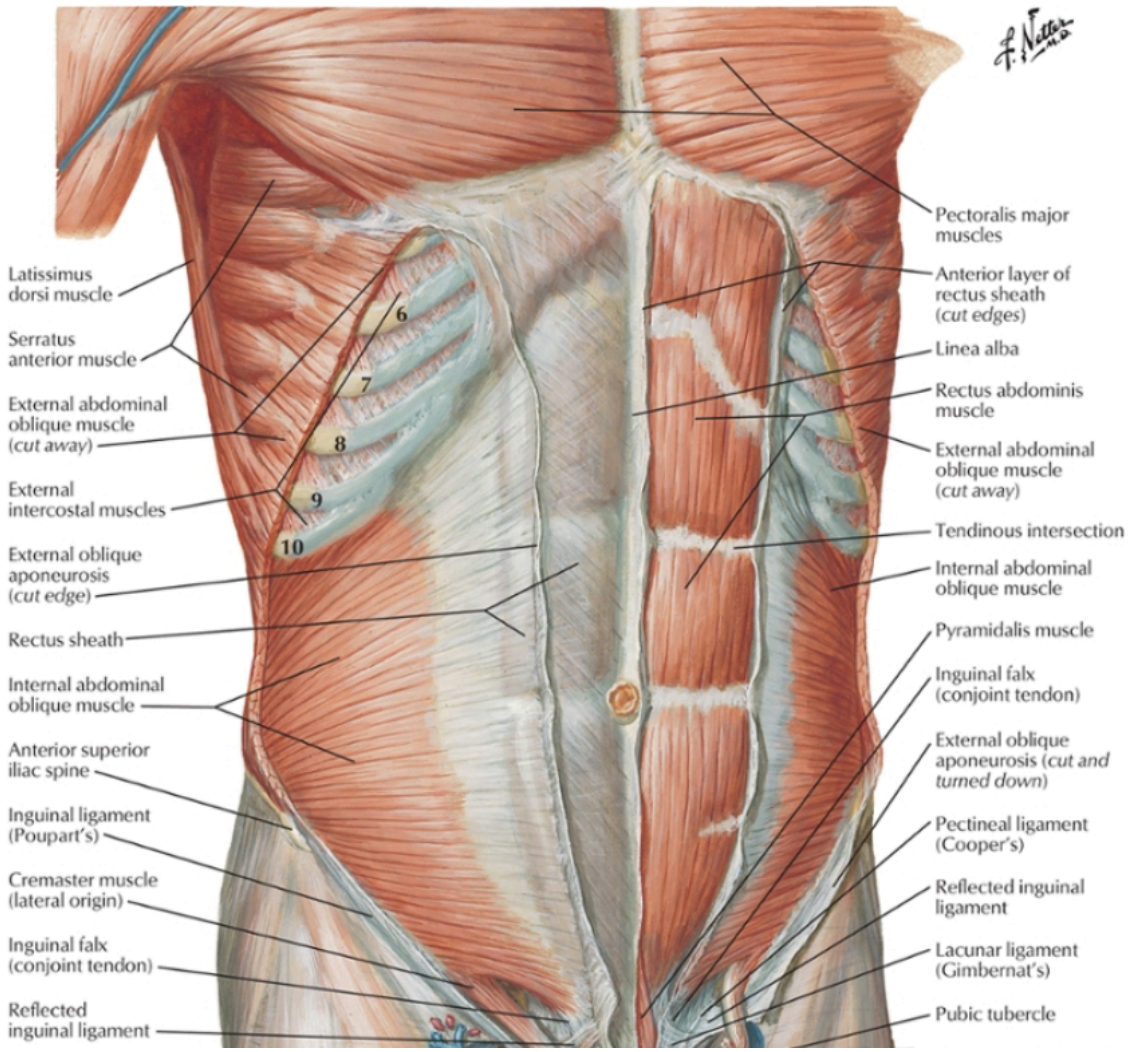

Figure 6.Anterior abdominal wall: intermediate dissection.(5)

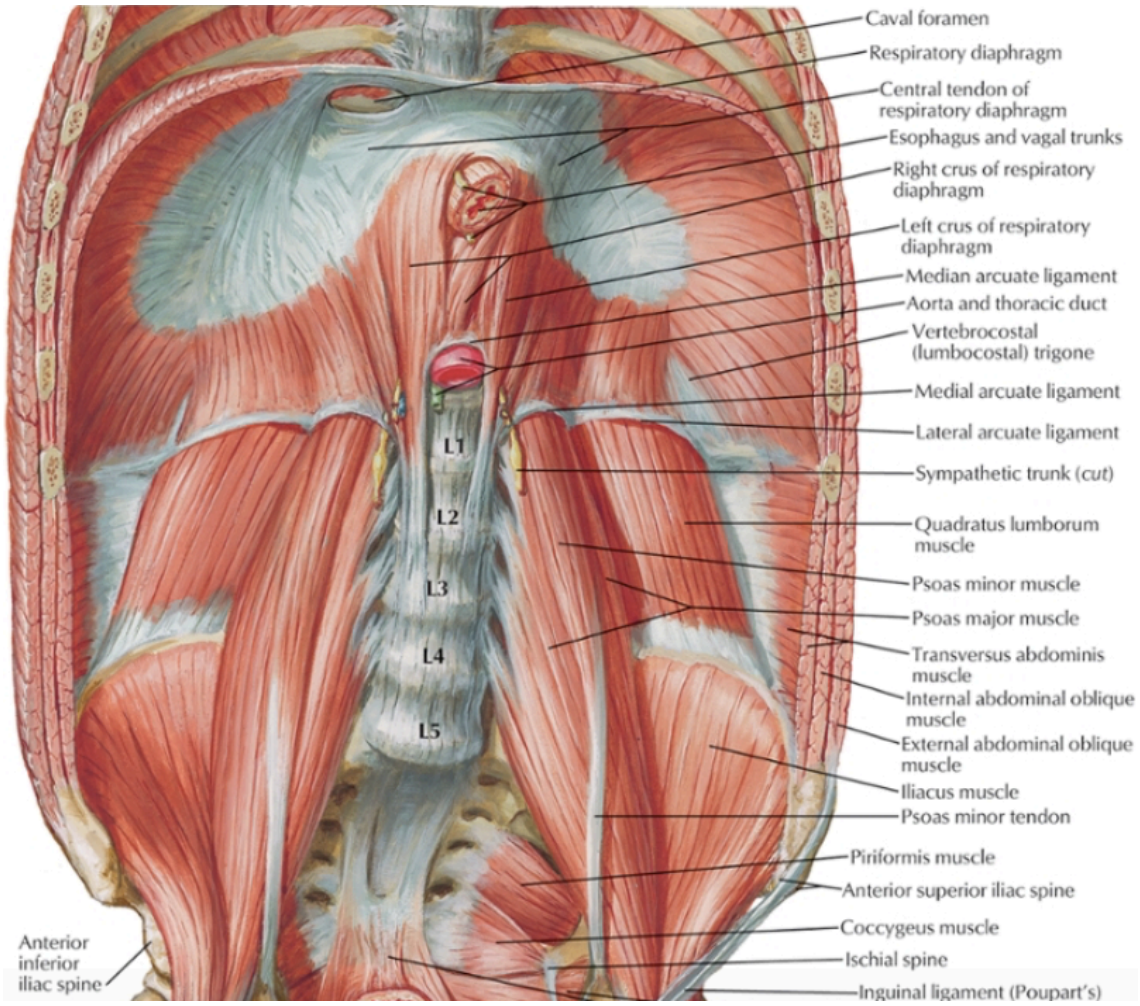

Figure 7: Posterior abdominal wall: internal view.(5)

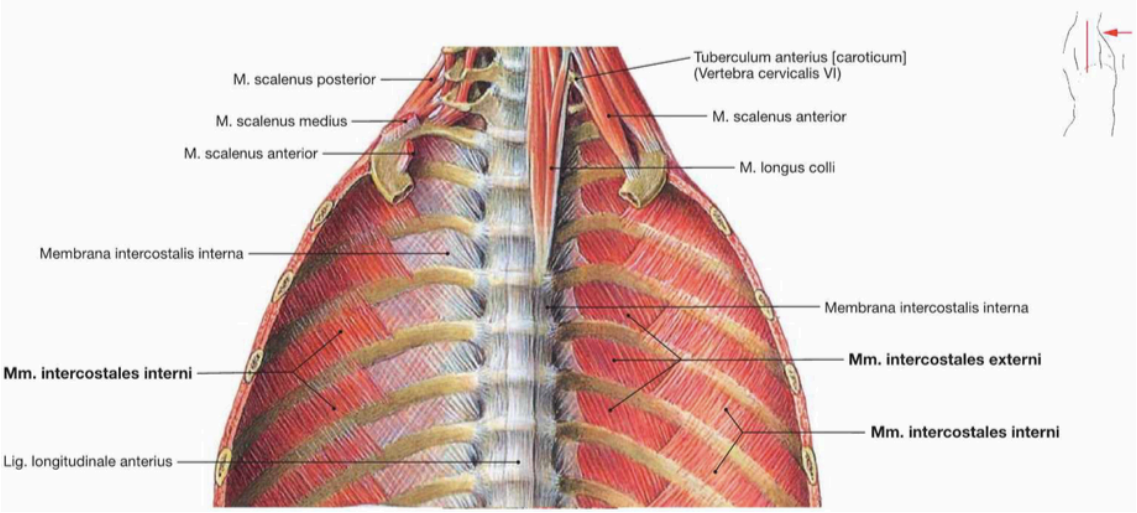

Figure 8: Posterior wall of the thoracic cavity: ventral view.(14)

Muscle	Origin	Insertion	Innervation	Main functions
Respiratory diaphragm	Xiphoid process, lower six costal cartilages, L1–L3 vertebrae	Converges into central tendon	Phrenic nerve	Draws central tendon down and forward during inspiration
External intercostal	Lower border of ribs	Upper border of rib below rib of origin	Intercostal nerves	Supports intercostal spaces in inspiration and expiration, elevates ribs in inspiration
Internal intercostal	Lower border of ribs	Costal cartilage and edge of costal groove of rib above rib of origin	Intercostal nerves	Prevents pushing out or drawing in of intercostal spaces in inspiration and expiration, lowers ribs in forced expiration
Innermost intercostal	Lower border of ribs	Upper border of rib below rib of origin	Intercostal nerves	Elevates ribs
Subcostal	Internal surface of lower ribs near their angles	Superior borders of 2nd or 3rd rib below	Intercostal nerves 2nd–5th	Depresses ribs
Rectus abdominis	Pubic symphysis, pubic crest	Xiphoid process, costal cartilages 5–7	Anterior rami of six inferior thoracic nerves	Flexes trunk, compresses abdominal viscera
Transversus abdominis	Internal surfaces of costal cartilages 7–12, thoracolumbar fascia, iliac crest, lateral third of inguinal ligament	Linea alba with aponeurosis of internal abdominal oblique, pubic crest, and pecten pubis via conjoint tendon	Anterior rami of six inferior thoracic and first lumbar nerves	Compresses and supports abdominal viscera
External abdominal oblique	External surfaces of ribs 5–12	Linea alba, pubic tubercle, anterior half of iliac crest	Anterior rami of six inferior thoracic nerves	Compresses and supports abdominal viscera, flexes and rotates trunk
Internal abdominal oblique	Thoracolumbar fascia, anterior 2/3 of iliac crest, lateral half of inguinal ligament	Inferior borders of ribs 10–12, linea alba, pubis via conjoint tendon	Anterior rami of six inferior thoracic and first lumbar nerves	Compresses and supports abdominal viscera, flexes and rotates trunk
Quadratus lumborum	Medial half of inferior border of 12th rib, tips of lumbar transverse processes	Iliolumbar ligament, internal lip of iliac crest	Anterior rami of T12 and first four lumbar nerves	Extends and laterally flexes vertebral column, fixes 12th rib during inspiration
SCM	Manubrium and medial portion of the clavicle	Mastoid process of the temporal bone, superior nuchal line	Accessory nerve	Unilaterally: contralateral cervical rotation, ipsilateral cervical flexion Bilaterally: cervical flexion, elevation of sternum and assists in forced inhalation.

Scalenius anterior	Anterior tubercles of the transverse processes of the 3rd,4th, 5th and 6th cervical vertebrae	Scalene tubercle on the inner border of the first rib, and into the ridge on the upper surface of the second rib in front of subclavian groove	Anterior rami of cervical nerve 5 and 6	Bilateral contraction: neck flexion Unilateral contraction: neck lateral flexion(ipsilateral), neck rotation (contralateral), elevates 1st rib
Scalenius posterior	Posterior tubercles of the trassverse processes of the lower 2-3 cervical vertebrae	Outer surface of the second rib, behind the attachment of anterior scalene	Anterior rami of cervical nerves 6-8	Neck lateral flexion, elevates 2nd rib
Scalenius medius	Posterior tubercles of the transverse processes of the lower six cervical vertebrae	Upper surface of the first rib, posterior to subclavian groove	Anterior rami of cervical nerve 3-8	Neck lateral flexion, elevates 1st rib
Pectoralis major	Sternal half of clavicle, sternum to 7th rib, cartilages of true ribs, aponeurosis of external abdominal oblique	Lateral lip of intertubercular sulcus of humerus	Medial and lateral pectoral nerves	Flexes, adducts, and medially rotates arm
Pectoralis minor	Outer surface of upper margin of ribs 3–5	Coracoid process of scapula	Medial pectoral nerve	Lowers lateral angle of scapula and protracts scapula
Serratus anterior	Lateral surfaces of upper 8–9 ribs	Costal surface of medial border of scapula	Long thoracic nerve	Protracts and rotates scapula and holds it against thoracic wall
Latissimus dorsi	Spinous processes of T7–L5, thoracolumbar fascia, iliac crest, and last three ribs	Intertubercular sulcus of humerus	Thoracodorsal nerve	Extends, adducts, and medially rotates humerus
Serratus posterior superior	Nuchal ligament, spinous processes of C7–T3	Superior aspect of ribs 2–5	Anterior rami of upper thoracic nerves	Elevates ribs

Trapezius	Superior nuchal line, external occipital protuberance, nuchal ligament, spinous processes of C7–T12	Lateral third of clavicle, acromion, spine of scapula	Accessory nerve	Elevates, retracts, and rotates scapula; lower fibers depress scapula

Table 1: Muscle group of the respiration

2.2.1 The accessory muscles of respiration

The accessory inspiratory muscles are the sternocleidomastoid, scalenus anterior, medius, and posterior, pectoralis major, pectoralis minor, upper part of trapezius, inferior fibers of serratus anterior and latissimus dorsi, serratus posterior superior may help in inspiration also the iliocostalis cervicis. Technically any muscle attached to the upper limb and the thoracic cage can act as an accessory muscle of inspiration through reverse muscle action. (24)

The accessory expiratory muscles are the abdominal muscles: rectus abdominis, external and internal oblique, and transversus abdominis. (24)

2.2.2 Mechanism of inhalation

The act of inhalation occurs due to increase in the volume of the chest cavity in three directions - vertical, sagittal, and frontal. It happens due to the raising of the ribs and the lowering of the diaphragm. In the state of exhalation, the ribs are lowered down, and in the state of inhalation, they take a more horizontal position, rising upward, while the lower end of the sternum moves forward. In addition, in inspiration the diaphragm is shortened, as a result of which it becomes flattered and moves caudally. (10)

The ribs are levers of the second kind with a pivot point at their joints articulations to the spine. During contraction, the external intercostal muscles should bring the ribs closer together, but since the moment of force at the lower attachment of the muscles is greater than that of the upper one due to the large length of the lever, the

ribs rise when the muscles contract. (10)

When inhaling, the volume of the chest and the lungs in it increases, while the pressure in it decreases and air enters the pulmonary alveoli through the airways. (10)

2.2.3 Mechanism of exhalation

During the inhalation, the respiratory muscles overcome several forces: the gravity raised upwards; elastic resistance to the rib cartilage; resistance to the walls of the abdomen and internal organs. When the inhalation period is over and the breathing muscles relax, the ribs move caudally, and the dome of the diaphragm is raised. Thus, the act of exhalation occurs usually passively, without muscle participation. With a forced exhalation to the listed forces that reduce the amount of the chest, the activation of additional muscles is present. (10)

With the contraction of the internal intercostal muscles, the ribs are lowered. The abdominal muscles, when they contract, push the abdominal organs and the dome of the diaphragm upward. During the exhalation, the volume of the chest, and lungs, decreases, the pressure in the alveoli rises and the air goes out of the lungs. (10)

2.3 Pneumonia

Pneumonia is an infection of the lungs with a range of possible causes, characterized by focal lesions of the respiratory parts of the lungs with the obligatory presence of inflammation of alveoli. Infective or chemical agents breach lung defences, inflame lung parenchyma and smallest bronchioles, then fill and consolidate alveoli with fibrous exudate. All this processes increases the work of breathing, thus gaseous exchange cannot occur physiologically. Pneumonia may have different ethology, pathogenesis, and morphological characteristics.(2;13;17)

The symptoms of pneumonia can range from mild to severe and include:

shortness of breath, chest pain, cough, fever, weakness, nausea, vomiting, difficulties to breath. The symptoms can vary for different groups. (17)

2.3.1 Pathophysiology of pneumonia

Most cases of pneumonia are caused by microorganisms that travel from the nasopharynx to the lower respiratory tract.

Pathogen adherence to the epithelium of the upper respiratory tract is the first step in colonization and subsequent infection. In the nasopharynx, bacteria leave the mucus and attach to the epithelium. Microorganisms most often enter the lower respiratory tract through the respiratory tract, and in rare cases, through pleural seeding from blood. Infection occurs when the host's defences are violated or when exposed to a highly virulent microorganism or a large inoculum. Few factors can facilitate the transition from colonization to infection, including prior viral infection and chronic lung disease. Other mechanisms involved in increased susceptibility to infection include loss of barrier integrity and impaired defences due to complex interactions between anatomical structures, the microorganism, and the host's immune system. (13)

It is difficult to determine the general mechanism of lower respiratory tract infection. The many different microorganisms that can cause pneumonia are not specific. Even in certain populations, a spectrum of pathogens, not a specific microorganism, can cause pneumonia. In addition, the development of pneumonia largely depends on the host's response to the microbe in the respiratory tract, while the characteristics of the pathogen sometimes play a less important role. However, virulence factors expressed by microorganisms do contribute to the ability of specific pathogens to cause pneumonia. (13;17)

Following the onset of lower respiratory tract infection (LRTI), the maintenance

of lung homeostasis in the presence of microbes depends on an adequate balance between two opposing processes, immune resistance, and tissue resistance. While immune resistance aims to eliminate invading microbes, tissue resistance has the aim to prevent or eliminate tissue damage caused by an immune response or pathogen. The orchestrated actions of immune and tissue resistance determine whether the LRTI will progress or resolve. Inappropriate treatment can lead to adverse outcomes such as ARDS, hypoxemia, and the need for mechanical ventilation. Imbalanced immune responses during pneumonia can also lead to extrapulmonary complications, some of which may occur several years after the illness. (13)

2.3.2 Pneumonia types

The main types of pneumonia are:

1. Bacterial pneumonia - caused by various bacteria, the most common of which is Streptococcus pneumoniae. Bacterial Pneumonia occurs when pneumonia-causing bacteria masses and multiplies in the lungs. The alveoli become inflamed and pus is produced, which spreads around the lungs. It usually occurs when the body is weakened due to illness, poor nutrition, old age, or impaired immunity. (11;15;34)

2. Viral pneumonia. This type is caused by various viruses, including influenza, and is responsible for about 1/3 of all pneumonia cases. (15;17)

3. Mycoplasma pneumonia. This type has different symptoms and physical signs and is referred to as atypical pneumonia. It is caused by the bacterium Mycoplasma pneumoniae. This usually causes mild, widespread pneumonia that affects all age groups. (15)

4. COVID-19 pneumonia. This type is caused by coronavirus and often have

very similar symptoms as viral pneumonia also including low saturation level (95-90%), affection of both lungs and characteristic ‘ground glass’ appearance visible on CT scan. Coronavirus pneumonia is very frequent complication in patients with COVID-19. (76)

5. Other pneumonia. Other less common pneumonia can be caused by other infections, including fungi. (15)

2.3.3 Pneumonia classification

Pneumonia can be classified according to etiology, location acquired, clinical features, and the area of the lung affected by the pathology. (15)

Etiology:

1.Primary pneumonia.

2.Secondary pneumonia (15).

Location acquired:

1.Community-acquired pneumonia (CAP): pneumonia that is acquired outside of a healthcare establishment. The most commonly identified pathogens are Streptococcus pneumoniae, Haemophilus influenzae, atypical bacteria, and viruses.(3;53;58)

2.Hospital-acquired pneumonia (HAP): develops at least 48 hours after hospital admission. The most common pathogens are gram-negative bacilli and Staphylococcus aureus. (19;20)

3. Healthcare–associated pneumonia (HCAP). Infection in individuals who have contact with health care settings such as nursing homes, patients hospitalized within prior 90 days for longer than 2 days. (53)

4. Ventilator-associated pneumonia (VAP): develops at least 48 hours after endotracheal intubation (typically in the intensive care unit). The most common pathogens are gram-negative bacilli and Staphylococcus aureus. (57;62)

Clinical features:

1.Typical pneumonia- pneumonia featuring classic symptoms, manifests as lobar pneumonia or bronchopneumonia. (15)

2. Atypical pneumonia- pneumonia with less distinct classical symptoms and often unremarkable findings on auscultation and percussion, manifests as interstitial pneumonia. (15)

Area of lung affected by the pathology:

1.Lobar pneumonia- pneumonia affecting one lobe of a lung. Multilobar pneumonia refers to the involvement of multiple lobes in a single lung or both lungs. Panlobar pneumonia involves all the lobes of one lung. (17)

2.Bronchial pneumonia- pneumonia affecting the tissue around the bronchi or bronchioles.(17)

3.Interstitial pneumonia- pneumonia affecting the tissue between the alveoli. (17)

4.Cryptogenic organizing pneumonia- noninfectious pneumonia of unknown ethology characterized by the involvement of the bronchioles, alveoli, and surrounding tissue. (17)

2.3.4 Medical treatment of pneumonia

Most cases of pneumonia can be solved without hospitalization. Several tools have been developed to help determine appropriate treatment settings. The CURB65 assessment tool calculates the risk of 30-day mortality, it uses 5 variables (confusion, urea, respiratory rate, blood pressure, and age), with one point awarded for each if present. (20)

A CURB65 score of 0 or 1 demonstrates a low risk of mortality and suggests a patient can be managed in the outpatient setting. A score of 3 or higher should warrant

hospital admission. (20)

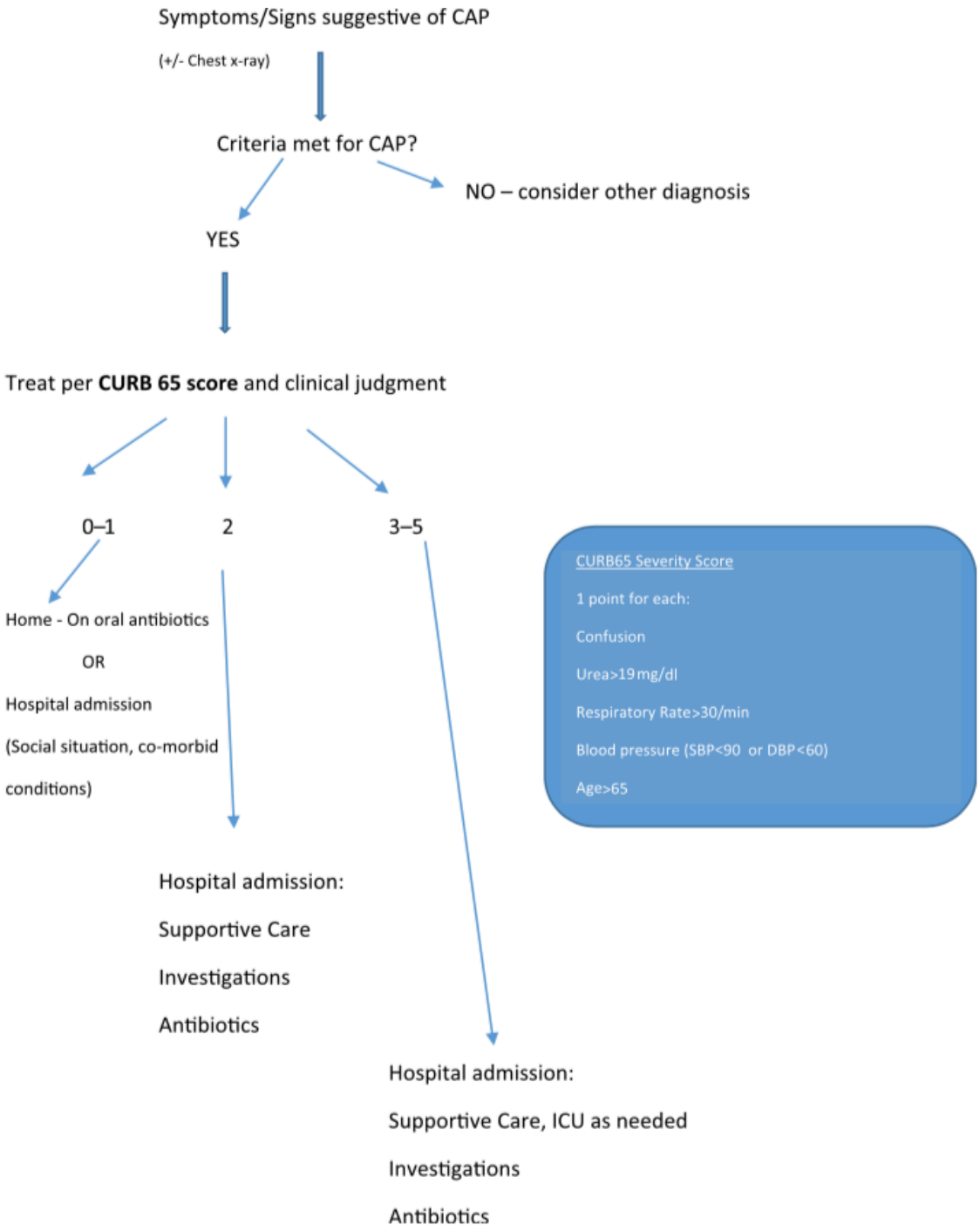

Figure 9: CURB65 score to determine appropriate treatment settings for pneumonia treatment. (20)

Treatment is by oral or intravenous fluids, antiviral or antibacterial drugs, and oxygen if indicated 12. In previously healthy patients who are appropriate for outpatient treatment, recommended first-line treatment is with a macrolide antibiotic such as azithromycin targeting the most common causal pathogen S. pneumoniae. Doxycycline is an alternative option. (20)

Patients with comorbidities such as diabetes; chronic heart, lung, renal, or liver disease; alcoholism; asplenia; impaired immune system; or recent antibiotic use within the last 3 months have an increased risk for drug-resistant S pneumoniae. As such, a respiratory fluoroquinolone or b-lactam plus a macrolide is recommended. (20)

2.3.5 Physiotherapy for pneumonia

The patient requires respiratory physiotherapy by vibrations and shaking to mobilize secretions, cough to expectorate secretions, the appropriate positioning of the patient to increase air entry, increase chest expansion, and loosen secretions. Physiotherapeutic procedures can be provided before and during suctioning. If the patient is able, other techniques to clear secretions can be used. (8;54)

Physiotherapy contributes to reducing mechanical ventilation support need, number of hospitalisation days, the incidence of respiratory infection, and risk of mortality. (9;12;25)

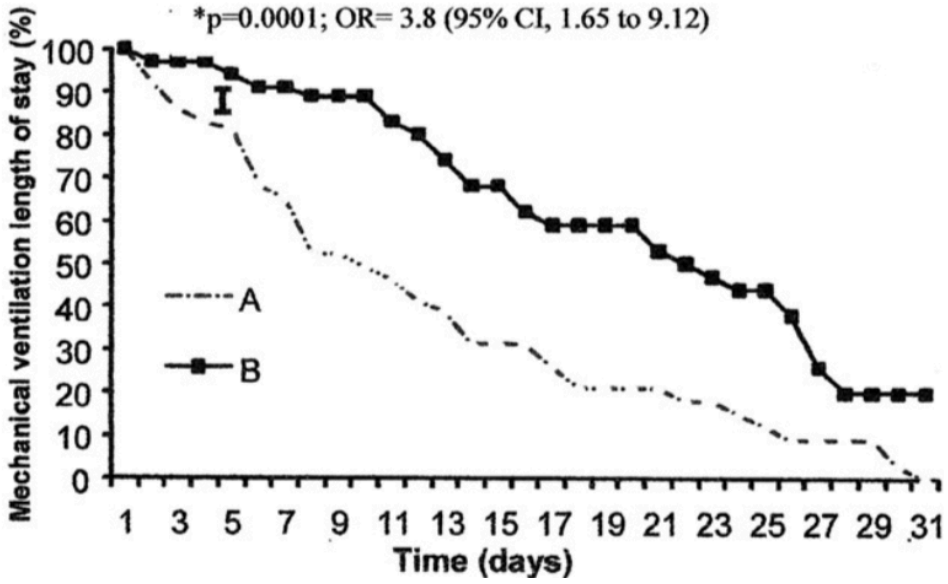

Figure 10: Days patients remained on mechanical ventilation support in services A (daily physiotherapy care) and B (rare physiotherapy care). (25)

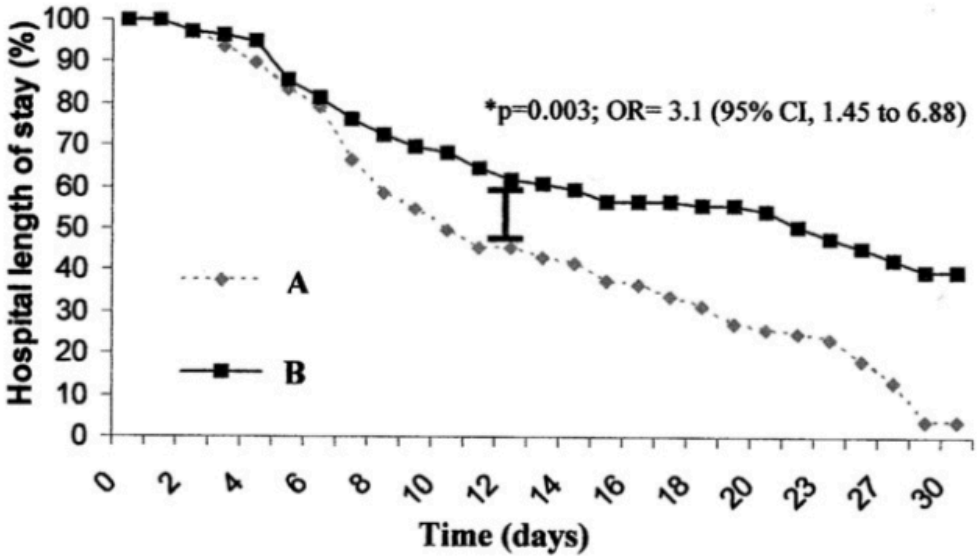

Figure 11: Days patients remained hospitalized in services A (daily physiotherapy care) and B (rare physiotherapy care). (25)

2.4 Coronavirus disease 2019

2.4.1 General information

Coronavirus disease or also called COVID-19 is a single-stranded RNA virus that belongs to the family Coronaviridae virus and caused by severe acute respiratory syndrome 2 (SARS-CoV-2). The genetic similarity of the new virus with the previously known coronaviruses Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) (~ 79% similarity) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV) (~ 50% similarity) was shown. The S-protein of the SARS-CoV-2 virus is similar to the receptor for angiotensin-converting enzyme (ACE2), and its affinity for this receptor is 10-20 times higher than that of SARS-CoV, which ensures high contagiousness. (73)

The receptor for ACE2 is expressed in the epithelium of the respiratory tract, alveolar monocytes, vascular endothelium, epithelium of the gastrointestinal tract, urinary tract, macrophages, and other cells of many organs and tissues, including the myocardium and some parts of the central nervous system. SARS-CoV-2 is capable of the most active replication in the upper respiratory tract. (55;73)

The tropism of the virus to the upper respiratory tract epithelium probably explains the continuous shedding of the virus from the pharynx and the more efficient transmission of SARS-CoV-2 than SARS-CoV. The course and progression of COVID-19 disease to a certain extent resembles severe acute respiratory syndrome (SARS) by viral replication in the lower respiratory tract with the development of severe immune disorders and hypoxia, leading to damage to many target organs: heart, kidneys, brain, gastrointestinal intestinal tract and others, which underlies clinical deterioration in the second week and even later from the onset of the disease. However, the cardinal difference is the development of microangiopathy and hypercoagulable syndrome with thrombosis and thromboembolism, as well as damage to the organs of

the immune system. (55)

2.4.2 Morphology

Coronaviruses are enveloped, pleomorphic or spherical particles, 150- 160 nm in size, linked with constructive single-stranded RNA, unsegmented, nucleoprotein, capsid, matrix, and surface glycoprotein (S-protein). Significant viral proteins are nucleocapsid protein (N), spike glycoprotein (S), membrane (M), and envelope small membrane protein (E). COVID-19 differs from other coronaviruses by encoding a supplementary glycoprotein that has acetyl Esterase and Hemagglutination (HE) properties. (79)

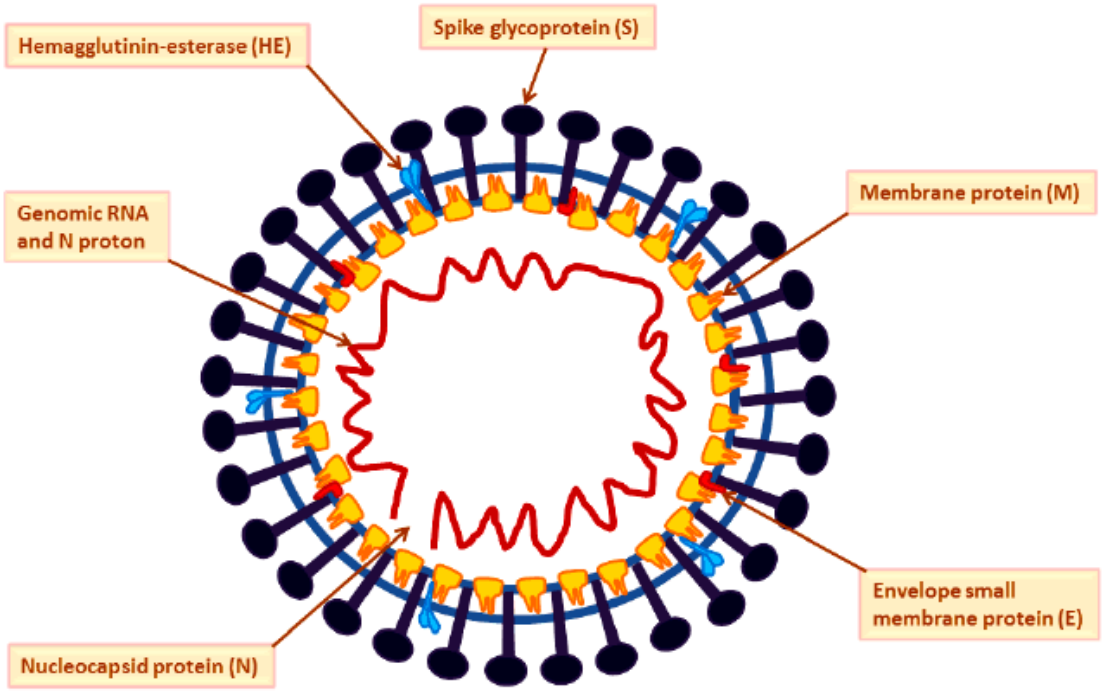

Figure 12: Schematic representation main structure of COVID-19 (79)

2.4.3 Pathogenesis

The main target cells for coronaviruses are the cells of the alveolar epithelium, in the cytoplasm of which the virus replicates. After assembly of virions, they pass into cytoplasmic vacuoles, which migrate to the cell membrane and, by exocytosis, exit into the extracellular space. Expression of virus antigens on the cell surface before the release of virions from the cell does not occur, therefore, antibody production and interferon synthesis are stimulated relatively late. The formation of syncytium under the influence of the virus makes it possible for the virus to spread rapidly in the tissue. (32;55)

The action of the virus causes an increase in the permeability of cell membranes and increased transport of albumin-rich fluid into the interstitial tissue of the lung and the lumen of the alveoli. In this case, the surfactant is destroyed, which leads to the collapse of the alveoli, as a result of a sharp violation of gas exchange, an acute respiratory distress syndrome develops. (32)

2.4.4 Pathophysiology of COVID-19

At autopsy, pathological changes of varying severity and prevalence were detected in all those who died from COVID-19 in the lungs, however, there was a simultaneous damage to other organs, which in some cases, in terms of its severity, could prevail over the pulmonary changes and cause death. (32;36)

Speaking of the lungs, the main signs include heavy and boggy lungs, patchy consolidation along with fibrinous pleural exudate and/or fibrosis, sometimes with purulent inflammation due to secondary bacterial infection with or without pericarditis. In severe cases the main morphological manifestation in the lungs is diffuse alveolar damage (DAD) in combination with the involvement of the pulmonary vascular bed in the pathological process and alveolar hemorrhage syndrome.(36;55)

Microscopic features depend on the stage and severity of the disease. In the early stages with asymptomatic patients, nonspecific changes are observed, including

pulmonary edema, focal hyperplasia of pneumocytes, focal chronic inflammatory infiltrate, and multinucleated giant cells with no observable of prominent hyaline membrane formation. (59)

As the disease progresses, DAD with the formation of a transparent hyaline membrane and severe pulmonary edema observed. However, in COVID-19, there is a firbomyxoid exudate with visible fibrinous cords, as well as mucous plugging of the bronchioles, which is related to oxygen therapy. Interstitial inflammatory infiltrates with severe epithelial damage and diffuse type II pneumocyte hyperplasia corresponding to acute respiratory distress syndrome (ARDS) are also widespread. (69)

Attachment of a bacterial (or, rarely, mycotic) infection in the form of viral-bacterial and mycotic pneumonia, as well as sepsis and septic shock was characteristic mainly in patients who were on mechanical ventilation for more than a week (35-40%). (69).

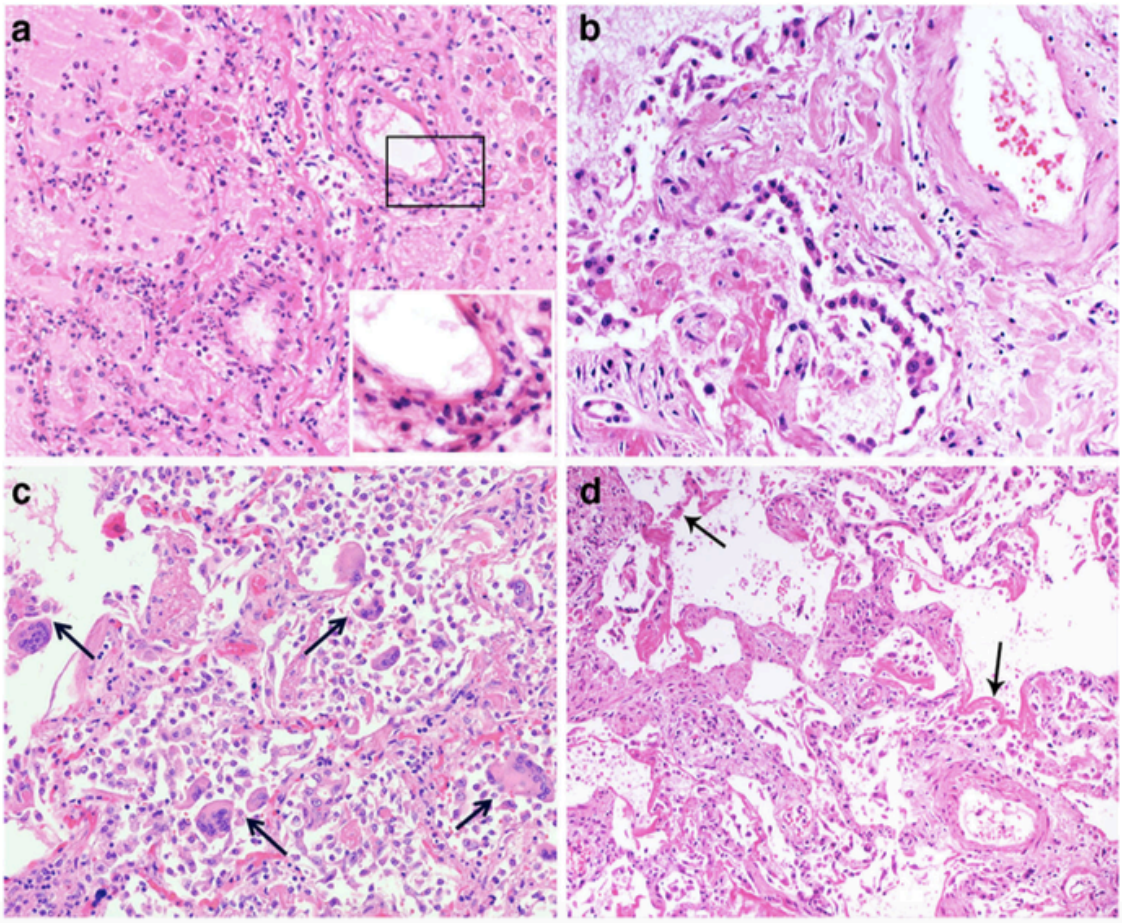

Figure 13: Pulmonary pathology of fatal COVID-19.

- a- Incipient pulmonary damage in early-stage disease with intraalveolar edema, endothelial necrosis, microthrombosis, and endothelialitis. Insert with progressive inflammatory vascular injury with nuclear debris and granulocytes.

- b - Pneumocyte type 2 hyperplasia in exudative phase of DAD.

- *c - Multiple intraalveolar giant cells in exudative phase DAD.*
- *d - Hyaline membranes and solid fibrin deposits in exudative phase DAD. (69)*

2.4.5.Histopathological findings

S.N.	Histopathogical findings
	Respiratory system: Lung
1.	► **Alveoli:** Damaged or atypical enlarged pneumocytes with large nuclei, type II pneumocyte hyperplasia, diffuse alveolar damage (DAD), focal sloughing, hyaline membrane formation, intra-alveolar haemorrhage, intra-alveolar neutrophil infiltration, amphophilic granular cytoplasm and prominent nucleoli characteristic of viral cytopathic-like changes. ► **Vessels:** Oedematous and congested vessels, plug formation, fibrinoid necrosis of the small vasculature, hyaline thrombi in microvessels. Significant deposits of complements—C5b-9 (membrane attack complex), C4d, and mannose binding lectin (MBL)-associated serine protease (MASP)-2, in the microvasculature. ► **Cellular components:** Presence of syncytial giant cells, focal infiltration of immune and inflammatory (lymphocytes and monocytes) and increased stromal cells. ► **Ultrastructural changes:** Viral particles in bronchial mucosal epithelia and type II alveolar epithelia.
	Urinary system: Kidney
2.	► **Glomerulus:** Ischaemic changes, podocyte vacuolation, focal segmental glomerulosclerosis, accumulation of plasma in Bowman's space. ► **Renal tubules:** Loss of brush border in proximal tubule, non-isometric vacuolar degeneration, and necrosis, oedematous epithelial cells. ► **Vessels:** Erythrocyte aggregates obstructing the lumen of capillaries without platelet or fibrinoid material with occasional hemosiderin granules and pigmented casts, hyalinosis of arteriole, arteriosclerosis of medium sized arteries, fibrin thrombus, shrinkage of capillary loops in glomeruli. ► **Ultrastructural changes:** Clusters of viral particles with distinctive spikes in the tubular epithelium and podocytes.
	Gastrointestinal system
3.	► **Liver:** Focal macrovesicular steatosis, nuclear glycogen accumulation in hepatocytes, dense atypical small lymphocytes in portal tracts. Regenerative nodules and thick fibrous bands, mild zone 3 sinusoidal dilatation, mild lobular lymphocytic infiltration. Patchy hepatic necrosis in the periportal and centrilobular areas. Hepatic cell degeneration and focal necrosis, biliary plugs in the small bile duct. ► **Oesophagus:** Occasional lymphocytic infiltration in the oesophageal squamous epithelium. ► **Stomach:** Partial epithelial degeneration, necrosis and shedding of the gastric mucosa. Dilatation and congestion of small blood vessels and oedema of lamina propria and submucosa with infiltration of immune cells (as lymphocytes, monocytes and plasma cells). ► **Intestine:** Stenosis of the small intestine and segmental dilatation. Numerous infiltrating plasma cells and lymphocytes with interstitial oedema in the lamina propria. ► **Pancreas:** Degeneration of the cells of islets.
	Cardiovascular system
4.	► Foci of lymphocytic inflammation. ► Acute myocyte necrosis. ► Presence of inflammatory cells and apoptotic bodies. ► **Ultrastructural observation:** Viral inclusion bodies in vascular endothelial cells. ► **Immunohistochemistry:** Presence of CD61+ megakaryocytes in purpuric papulovesicular.
	Reproductive system
5.	► Thickened basement membrane with peritubular fibrosis and vascular congestion. ► Leucocyte infiltration. ► Extensive germ cell destruction. ► **TUNEL assay:** Increased apoptotic spermatogonic cells.
	Nervous system
6.	► Acute hypoxic ischaemic injury, hyperaemia, oedema and neuronal degeneration. ► **CT, MRI:** Ischaemia and/or haemorrhage, and enhanced cortical/subcortical grey matter and fibre tracts. ► SARS-CoV-2 RNA was detected in the brain tissue and cerebrospinal fluid in some patients.
	Histopathogical findings (skin)
7.	► **Vessels:** Perivascular inflammatory cells, intraluminal thrombi. ► **Epidermis:** Parakeratosis, acanthosis, dyskeratotic keratinocytes, necrotic keratinocytes, acantholytic clefts, lymphocyte satellitosis and pseudoherpetic. ► **Immunohistochemistry:** ACE-2 positivity in basal layer of cells in hair follicle, sebaceous glands, smooth muscle cells.

Figure 14: Important histopathogical findings of systems/organs observed by authors in different studies. (46)

2.4.6 Clinical features

COVID-19 can be divided into 3 forms: mild, moderate, and severe. Generally, 81% of infected patients were categorized as mild. About 14% of the patients were categorized as severe and presented with dyspnea, blood oxygen saturation 92%, and lung infiltrate>50%. The remaining 5% were classified as critical and presented with respiratory failure, septic shock, or multiple organ dysfunction, which resulted in a high mortality rate of 50%. (48)

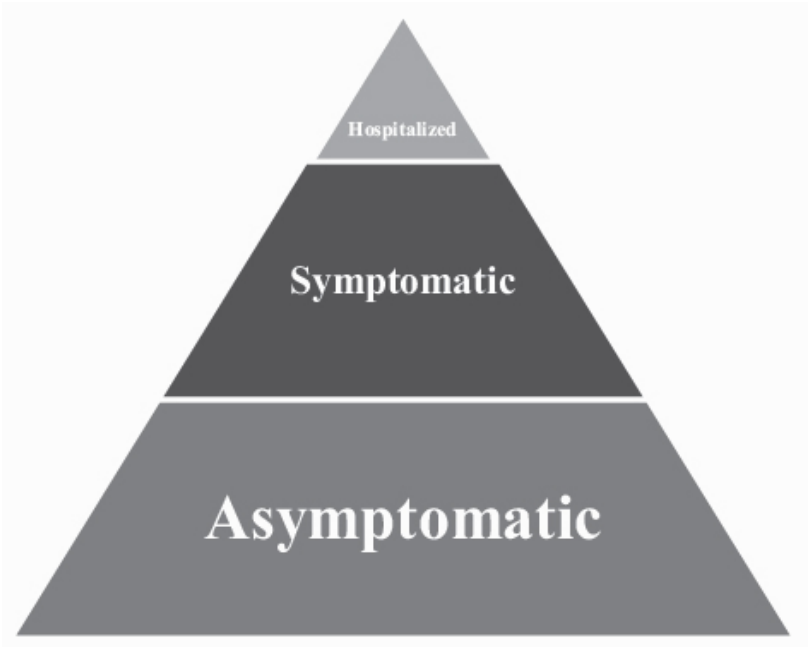

Figure 15: Clinical presentation of COVID-19. (74)

Most patients with severe COVID-19 develop pneumonia in the first week of illness. In the lungs, moist crepitating, fine bubbling rales are heard on both sides. With percussion, the dullness of the pulmonary sound is determined. When inhaling, wheezing becomes more intense, after coughing, it doesn't disappear and doesn't change depending on the position of the patient's body. Radiography reveals infiltration in the peripheral parts of the pulmonary fields. With the progression of the process, infiltration

increases, the affected areas became larger, and develops ARDS. Sepsis and infectious toxic shock are observed as the infection progresses. (55;74)

2.4.7 Symptoms

The symptoms of coronavirus are often similar to cold or flu, but it may differ from individual to individual, sometimes the patient won't have any symptoms. Common coronavirus symptoms may include the following (73;74):

-sneezing

-shortness of breath

-joint pain

-chest pain

-aches

-diarrhoea

- headache

- loss of taste and smell

-cough

-fatigue

-fever

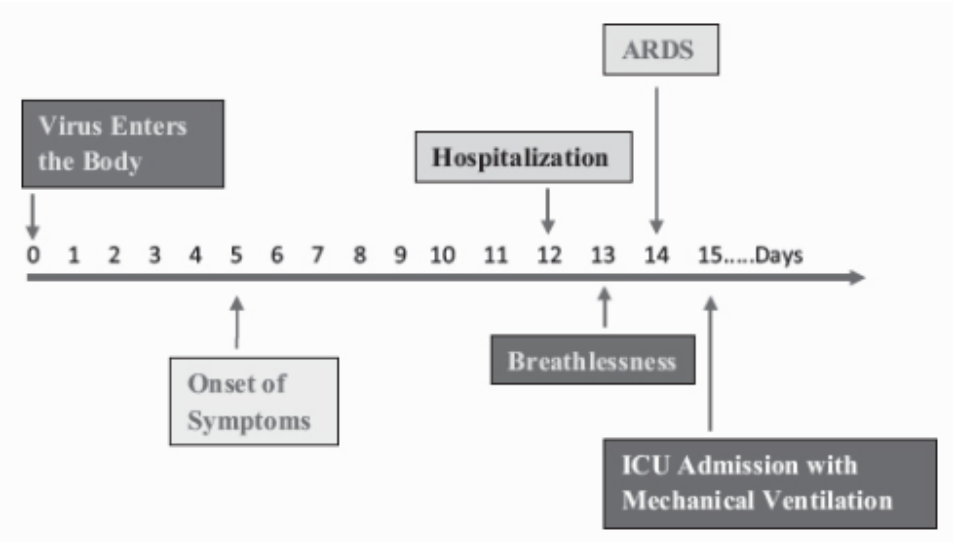

Figure 16: A timeline for the development of various symptoms of COVID-19. (73)

2.4.8 The effect of the COVID-19 on different organs

2.4.8.1 Heart

Approximately 20% of people hospitalized with COVID-19 also suffered from cardiac injury and were at higher risk of dying. Such cardiac problems included myocarditis, heart attacks, and irregular heartbeat rhythms.

Initially, doctors connected problems with the inflammatory effects of the virus, along with respiratory distress caused by pneumonia and ARDS, but they are now seeing other types of heart damage as well, leading them to believe the virus may injure the heart directly. (42;44)

2.4.8.2 Liver

Many people who become infected with the coronavirus have higher levels of enzymes that enter the bloodstream due to liver damage or inflammation.(51;75)

2.4.8.3 Kidneys

Some people who become infected with COVID-19 have been shown to experience acute kidney damage, including the need for emergency kidney transplantation.(51)

2.4.8.4 Brain

Researchers are increasingly finding evidence that coronavirus can attack the brain, causing neurological damage and even strokes. According to research, 30% of

COVID-19 patients have developed a wide range of neurological problems, including:

- dizziness
- headache
- impaired consciousness
- acute cerebrovascular diseases, including epilepsy
- peripheral symptoms, including decreased appetite, taste and smell.

There is also information about a small number of apparently healthy young people who have had a stroke and a positive result for COVID-19. Strokes were very unusual in people under the age of fifty, leading researchers to believe that COVID-19 causes a blood clotting problem that leads to strokes. (40;47;75)

2.4.9 The effect of COVID-19 to immune system

As with another type of infection, the human body starts to attack bacteria or a viral infection. In the case of the coronavirus, the body releases so many of its natural defences against the coronavirus, that it starts to cause inflammation in many organs of the body.(41)

2.4.10 Subacute and long terms effects of COVID-19

The scientific and clinical proof is evolving on the subacute and long term effects of new coronavirus disease, which may have an effect on multiple organ systems. Early reports counsel residual effects of COVID-19 infection, chest pain, excessive tiredness, dyspnea, psychological feature disturbances, pain, and decline in quality of life. The cellular damage, a robust innate immune response with inflammatory cytokine production, and a pro-coagulant state induced by SARS-CoV-2 infection may contribute to these sequelae. (77)

According to researches, 6 months after infection, COVID-19 survivors were mostly concerned about fatigue or muscle weakness, sleep problems, and anxiety or depression. Patients who were more severely ill during their hospital stay had more severe impairment of lung diffusion capacity and abnormal chest manifestations. (78)

2.4.11 Medical treatment of COVID-19

Currently, COVID-19 is mainly treated with drugs that had antiviral effects in previous clinical trials. Clinical trials have shown that various chemicals have some antiviral activity against COVID-19, although the drugs need further testing to confirm their effectiveness and safety.(43;52)

Drug names	Time points of blood collection	The range of concentrations	Principles of dosage adjustment
lopinavir/ ritonavir	(peak) 30 min after drug administration (trough) 30 min before drug administration	lopinavir: (trough) > 1 μg/mL (peak) < 8.2 μg/mL	Correlated with drug efficacy and side effects.
imipenem	10 min before the drug administration	1~8 μg/mL	Interpretation and adjust the plasma drug concentration based on MIC of the pathogen testing
meropenem	10 min before the drug administration	1~16 μg/mL	
vancomycin	30 min before the drug administration	10~20 mg/L (15~20 mg/L for the severe MRSA infection)	The trough concentration correlates with the failure rate of anti-infective therapy and renal toxicity. When the concentration is overly high, reduction of drug frequency or single dose is required.
linezolid	30 min before the drug administration	2~7 μg/mL	The trough concentration correlates with myelosuppression adverse reactions. The blood routine test needs to be closely monitored.
voriconazol	30 min before the drug administration	1~5.5 μg/mL	The trough concentration correlates with the therapeutic efficacy and adverse reactions such as impaired liver function.

Figure 17: The range of concentrations and points for attention of the common therapeutic drug monitoring (TDM) drugs for the COVID-19 patients.(6)

2.4.12 Physiotherapeutic treatment of COVID-19

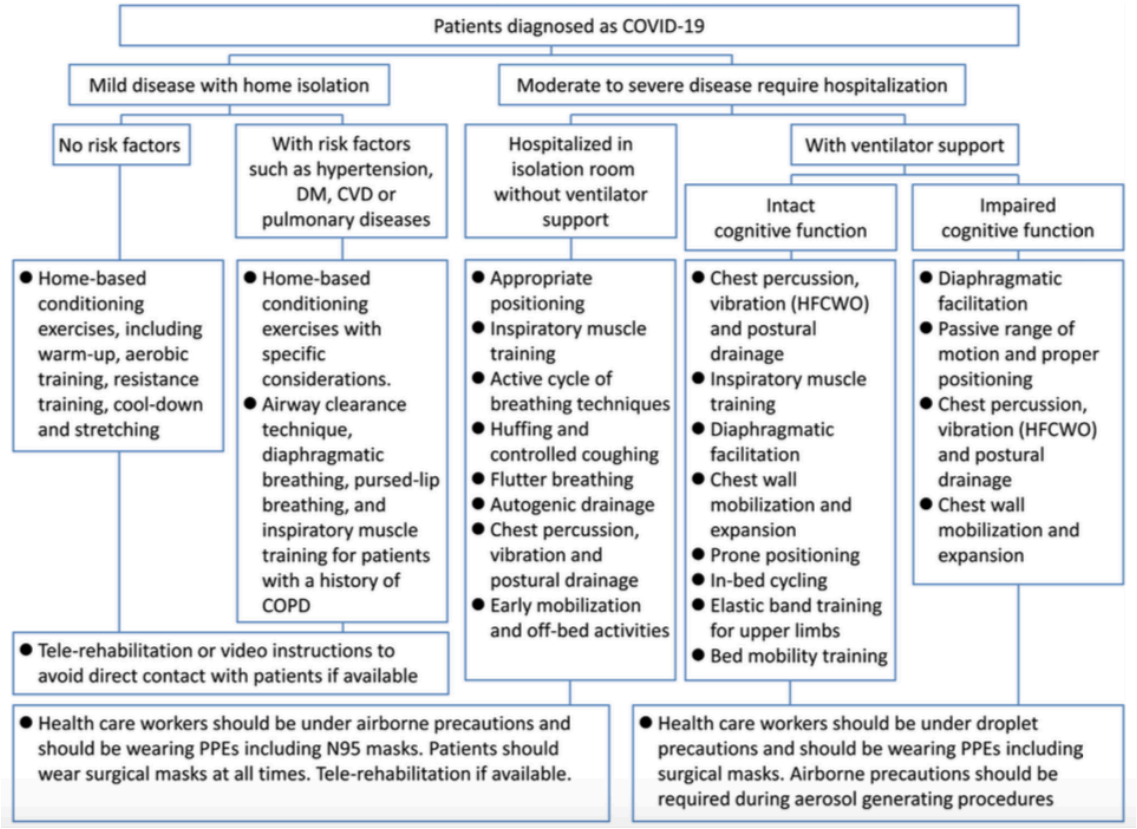

Figure 18: The flowchart of suggested rehabilitation interventions and infection precautions for patients with COVID-19.(48)

2.4.12.1 Physiotherapy for mechanically ventilated COVID-19 patients

Physiotherapy has proven to be effective in improving long-term physical function for the patients in the intensive care unit. Physiotherapy for the patients in critical and post-critical states is based on a multi-system approach that includes musculoskeletal rehabilitation to reduce the incidence of complications, encourage weaning from mechanical ventilation, and promote restoration of functional autonomy. (26;27;50)

Common chest physiotherapy techniques for critically ill patients, in general, include airway clearance techniques, respiratory physiotherapy, vibration techniques,

postural drainage, percussion, patient interaction with a ventilator, inhalation therapy, and airway suctioning to minimize pulmonary secretion retention and maximize oxygenation. (27;33;48)

For now, it's possible to find a little amount of literature on physical therapy during the COVID-19 pandemic, especially physiotherapy for patients in ICU.

2.4.12.2 Rehabilitation physiotherapy for severe, moderate COVID-19 forms and critically ill patients

Rehabilitation therapy for severe or critically ill COVID-19 patients mainly includes positioning, physical therapy witch includes respiratory exercises, and prevention of future complications. The two primary objectives of rehabilitation in this stage are promoting airway clearance and preventing complications of acute illness-related immobilization. (6;31;48)

1.Position management.

Postural drainage can reduce the influence of sputum on the respiratory tract which can help improve the patient's overall condition. Standing is the best resting position for breathing, which can effectively improve the patient's breathing efficiency and maintain lung capacity. If the patient cannot be in a standing position, it is recommended to sit in an erect position. (6:71)

2.Respiratory physiotherapy.

- Active cycle of breathing techniques (ACBT).

It can effectively remove bronchus excretion, improve lung function and reduce dyspnea. ACBT consists of three stages: breathing control, thoracic expansion, and exhalation. The breathing cycle should be corrected according to the patient’s condition. (6;60)

- Positive expiratory pressure trainer.

The pulmonary interstitium of COVID-19 patients is severely damaged. Mechanical ventilation requires low pressure and low tidal volume to avoid damage to the pulmonary interstitium. Thus, after mechanical ventilation is removed, a positive expiratory pressure trainer can be used to help move secretions from low-volume lung segments to high-volume lung segments, reducing the difficulty of passing sputum. Positive expiratory pressure can be created by vibrating the airflow, which vibrates the airways. The secretions can then be removed as the high-velocity expiratory flow moves the secretions.(6)

- Percussion and vibration of the chest.

Fluctuations in the chest wall, mechanical vibration, and chest percussion promote sputum discharge, especially in patients with an excessive amount of airway secretions.(65;72)

- Flutter Breathing.

This technique uses a device containing a movable steel ball in a sealed tube. The patient quickly pumps air into the tube, which shakes the steel ball and creates a rhythmic airflow. Flutter breathing could ultimately loosen the sputum within the airways. (72)

- Huffing and controlled cough.

Huffing is characterized by a rapid expiration of air without closing the glottis, while a controlled cough is aimed at preventing superficial and ineffective coughing. Both methods of coughing have been shown to reduce the force of coughing and improve airway clearance. (72)

3. Breathing exercises.

Exercise improves lung function and can help discharge from the alveoli and

airways into the larger airways so that phlegm does not accumulate at the bottom of the lungs. (49)

- Deep-slow breathing.

During inhalation, the patient should activate the diaphragm as much as it possible. Breathing should be as deep and slow as to avoid reducing the effectiveness of breathing. Compared to thoracic breathing, this type of breathing requires less muscle strength but has a better tidal volume and V/Q (ventilation/perfusion) value, which can be used to correct breathlessness. (49)

- Breathing with the expansion of the chest in combination with expansion of the shoulders.

This exercise helps to increased pulmonary ventilation. Taking a slow deep breath, the patient expands the chest and shoulders while inhaling; then during the exhalation patient has to push the chest and shoulders back. Suspension of breathing for a long time should be avoided so as not to increase the burden of the respiratory function and the heart. The respiratory rate should be 12-15 times / min if possible. (49)

4. Prevention of deterioration.

Immobilization accelerates functional decline with decreased muscle strength and cardiorespiratory fitness, especially among the elderly and patients with underlying medical conditions. After stabilization of the medical condition, early active or semi-active movements should be encouraged; if active movements are not possible, then mobilization should be performed passively. Patients with moderate to severe disease who can actively move their limbs are advised to perform active exercises to maintain or improve joint integrity, prevent joint contractures and soft tissue shortening. (6)

3.Case study

3.1 Methodology

My bachelor's practice took place at Institut Klinicke a Experimentalni Mediciny (IKEM) in Prague. The placement started on 18.1.21 and ended on 12.1.21, I attended 6h every day Monday-Friday, which in total 120 hours. My clinical work placement was supervised by Bc. Robert Charvat. I was in Oddeleni Anesteziologie a Resuscitace (ARO) most of the time, sometimes working in Transpantation department and other departments.

The first meeting with the patient took place on 22.1. in ARO, several days after the start of the practice. On the same day, the anamnesis and part of the initial kinesiological examination were taken. The duration of the therapy varied from 1 to 1.5 hours. Due to the fact that the patient passed away on 7.2., the final kinesiological examination could not be performed. To compare the initial stage before treatment and changes during therapy, the data from the therapeutical units are presented instead of the final kinesiological examination. In total, I was able to perform 10 therapies with the patient, the last therapy was 4.2.

On the first day, the patient was informed about the examination, therapy, and my work, and signed the informed consent, which was approved by The Ethics Committee at FTVS Charles University. Therapies were performed under the supervision of BC. Robert Charvat.

3.2 Anamnesis

Examined person: J.Z., female Year: 1945, 75yo

Diagnosis: Bacterial pneumonia

- Diabetes Melitus 2 type
- Chronic renal disease
- Bronchial asthma
- Bacterial pneumonia
- St.p. pulmonary embolia 3.2020
- St.p COVID-19 12.2020
- Hypertension
- Hyperlipidemia
- Hypothyroidism
- Ankylosing spondylitis

3.2.1.Status present

Objective:

- Height: 161cm
- Weight: 66kg
- BMI: 25,7
- Blood pressure: 140/100
- Saturation: 85%
- HR: 90/min
- Respiratory rate: 1/1
- Dominant limb: right
- Glasses: yes

- Cognition: ok
- Communication: she can communicate with the people and physiotherapists normally
- Assistive devices: oxygen mask
-

Subjective:

3.2.2 Chief complaint:

The patient is diagnosed with pneumonia after COVID-19. She is complaining about difficulties to breath, suffocation, chest tightness and not ability to make a deep breath. The patient feels severe weakness, tiredness and slight joint stiffness, however no joint or soft tissue (ST) structures pain.

3.2.3 History anamnesis:

The patient was diagnosed with pulmonary embolia 3.2020. She had rehabilitation in Motol Hospital for 3 weeks, no data from personal file concerning the rehabilitation (RHB).

17.11.20 she was diagnosed with COVID-19 and pneumonia, 20.11.2020 hospitalised to IKEM and 5.1.2021 transported ARO.

4.1.2021 PCR SARS-CoV-2 - negative.

Condition of the patient slightly get better but still her lungs are severely affected by pneumonia, pathological changes given by COVID-19 and pulmonary embolia. The saturation level is still very low even with oxygen mask.

3.2.4 Injury anamnesis:

Nothing to declare.

3.2.5 Surgery anamnesis:

Nothing to declare.

3.2.6 Pharmacological anamnesis:

Betaloc ZOK 25mg 1-0-0, Furon 40 mg 1-0-0, Milurit 200 mg 0-1-0, Sabgona combi 100/25 mg 1-0-0, Tenaxum 1-0-0, Verospiron 100 mg 0-1-0, Stadamet 1000 mg 1-0-1, Actos 30 mg 1-0-0, Humalog, Toujeo, inhalations.

3.2.7 Family anamnesis:

The patient's mother had hypertension and Diabetes Mellitus 2 type, died at the age 81. Father had hypertension, died at the age 84. Has daughter and son, both are healthy.

3.2.8 Social anamnesis:

The patient is very socially active, lives with her daughter and grandson in family house with 2 floors.

3.2.9 Occupational anamnesis:

Senior, in past worked as a manager.

3.2.10 Allergy anamnesis:

None.

3.2.11 Hobbies:

Reading, playing with her grandson.

3.2.12 Abuses:

The patient was a smoker for 7 years 2000-2007.

3.2.13 Prior rehabilitation:

The patient had rehabilitation due to pulmonary embolia 3.2020 for 3 weeks in Motol hospital, no data about the details of RHB. From 20.11.2020 she had RHB in IKEM which included corticosteroids therapy for COVID-19, antibiotics and other pharmacological treatment to decrease inflammation given by pneumonia, oxygenotherapy to increase saturation level . Physiotherapy included respiratory therapy, active and semi-active movements, verticalisations and soft tissue techniques (STT).

3.2.14 Excerpt from patient's health file:

X- Ray picture 21.1.21.

Both lungs spreading apart to periphery. Ground glass opacities on both lungs , bronchi have a thick wall. Fibrotic changes on both sides. Pleural effusion on both sides. Mediastinum is not expanded, the lymph nodes without changes.

Conclusion: Findings represent post-covid changes in lung parenchyma on both sides.

3.2.15 RHB indications:

- oxygen therapy
- respiratory physiotherapy

3.3 Initial kinesiological examination

Initial kinesiological examination (KE) had to be spread between two working days, because of the patient's weakness and excessive tiredness. The first part of KE was provided 22.1.21 on Friday, however, the second part of the examination was on Monday in two days. During the weekend doctors decided to put the patient in an induced coma due to her condition. The second part of the examination had to be provided when the patient was in an induced coma.

Due to the patient's condition, not all of the plained examinations were possible to provide.

For a week before the patient fall into a coma, she wasn't able to eat independently, the nutrition was delivered through the nasogastric (NG) tube. She could tolerate sitting in her bed in an erect position, independent sitting was not possible, the patient felt severe weakness and difficulties to breath. Standing or walking is was impossible. She is not able to make hygiene or take care of herself.

First part of initial KE.

3.3.1 Examination of breathing pattern

In supine position patient's breathing is mostly concentrated in the abdominal area, however, a slight breathing wave in uppper, middle, and lower thoracic regions is visible. In upper and middle thoracic regions chest movement in dorso-ventral direction is decreased on the right side and almost absent on the left side. The breathing wave is regular but very superficial, patient is not able to take a deep breath.

During chest palpation, pathological vibration given by pus was observed in inhalation stage with slight accompanying sounds in upper and middle thoracic regions on both sides, especially on right.

The lower part of the chest is not expanding laterally and dorsally on the left side and intercostal spaces are not widening, on the right side only slight expansion is

observed. Inhalation is accompanied by symmetrical shoulder elevation together with activation of sternocleidomastoid (SCM) muscle on the right side.

3.3.2 Neurological examination

Examination	Left	Right
Subjective light touch	Front of both thighs L2,L3-negative Medial and lateral aspect of both calves L4 and L5-negative Posteriot side of the calf-S1,S2-negative Little toes S1- negative Shoulders C4-negative Inner and outer aspects of forearms C6, Th1-negative Thumbs and little fingers C6-C8- negative	Front of both thighs L2,L3-negative Medial and lateral aspect of both calves L4 and L5-negative Posteriot side of the calf-S1,S2-negative Little toes S1- negative Shoulders C4-negative Inner and outer aspects of forearms C6, Th1-negative Thumbs and little fingers C6-C8- negative
Heat and cold sensations	Negative	Negative
Vibration sensations	Medial malleolus- negative Patellas- negative Anterior superior iliac spine- negative Spinous processes- x Clavicles-negative Elbows-negative Wrists-negative	Medial malleolus- negative Patellas- negative Anterior superior iliac spine-negative Spinous processes- x Clavicles-negative Elbows-negative Wrists-negative
Kinesthetic sensation	Negative	Negative

Position sense	Negative	Negative
Graphesthesia	Negative	Negative
Tactile discrimination	Negative	Negative
Pain sensation	Front of both thighs L2,L3-negative Medial and lateral aspect of both calves L4 and L5-negative Posteriot side of the calf-S1,S2-negative Little toes S1- negative Shoulders C4-negative Inner and outer aspects of forearms C6, Th1-negative Thumbs and little fingers C6-C8- negative	Front of both thighs L2,L3-negative Medial and lateral aspect of both calves L4 and L5-negative Posteriot side of the calf-S1,S2-negative Little toes S1- negative Shoulders C4-negative Inner and outer aspects of forearms C6, Th1-negative Thumbs and little fingers C6-C8- negative
Two point discrimination	Negative	Negative
Involuntary movements	Not present	Not present
Atrophy	Not present	Not present
Deep tendon reflexes	Patellar L2-L4-1(hypoactive response) Achilles L5-S2- 0 (absent) Flexors C8- 1(hypoactive response) Triceps C7- 1(hypoactive response) Biceps C5-C6- 0 (absent)	Patellar L2-L4- 1(hypoactive response) Achilles L5-S2-1(hypoactive response) Flexors C8- 1(hypoactive response) Triceps C7- 1(hypoactive response) Biceps C5-C6- 0 (absent)
Babinsky reflex	Negative	Negative

Juster reflex	Negative	Negative
Hoffmann's sign	Negative	Negative
Sicard reflex	Negative	Negative
Gordon reflex	Negative	Negative
Mendel-Bechterew reflex	Negative	Negative
Mingazzini sign- upper and lower extremities	Negative	Negative
Barre sign- upper and lower extremities	NegativeNegative	Negative
Laseque test	Negative	Negative
Chaddock	Negative	Negative
Openheim	Negative	Negative
Retardation phemonenon- upper and lower extremities	Negative	Negative

Table 2: Initial kinesiological examination- Neurological examination

3.3.3 Goniometry according to Kendall

Lower extremities					
	SFT R	Left		Right	
		AROM	PROM	AROM	PROM
Hip	S	x-0-115	x-0-120	x-0-120	x-0-120
	F	35-0-25	40-0-30	35-0-20	40-0-25
	R	45-0-30	50-0-35	40-0-35	45-0-40
Knee	S	0-0-130	0-0-135	0-0-130	0-0-135
Ankle	S	50-0- 30	50- 0-35	50-0-30	50-0-35

	R	20-0- 40	25-0-45	15-0-40	20-0-50

Table 3: Initial kinesiological examination- Goniometry. Lower Extremity (hip, knee and ankle joints)

Lower extremities- Foot					
	SFT R	Left		Right	
		AROM	PROM	AROM	PROM
MTP 1	S	40-0-65	45-0-70	40-0-70	45-0-75
	F	0-0-25	30-0-40	0-0-25	30-0-35
MTP2	S	30-0-70	40-0-75	35-0-70	45-0-75
	F	0-0-30	35-0- 40	0-0-30	35-0- 45
MTP3	S	30-0- 80	35-0-90	30-0-80	35-0-90
	F	0-0-35	30-0-40	0-0-40	30-0-40
MTP 4	S	30-0-85	35-0-90	10-0-80	15-0-85
	F	0-0-30	20-0-40	0-0-30	20-0-45
MTP 5	S	30-0-90	35 -0-95	30-0-85	35 -0-90
	F	15-0-50	30-0-60	15-0-40	30-0-45

Table 4: Initial kinesiological examination- Goniometry. Lower Extremity (foot)

Upper extremities					
	SFT R	Left		Right	
		AROM	PROM	AROM	PROM
Shoulder	S	x-0- 130	x-0-140	x-0-160	x-0-170
	F	x-0-110	x-0-125	x-0-170	x-0-180
	T	x-0-120	x-0-120	x-0-120	x-0-120
	R	50-0-50	55-0-50	45-0-50	50-0-50
Elbow	S	0-0-130	0-0-135	0-0-130	0-0-135

Wrist	S	50-0-40(cateter)	50-0-40(catheter)	70-0-80	75-0-80
	F	15-0-25	15-0-25	20-0-25	20-0-30
	R	90-0-90	90-0-90	90-0-90	90-0-90

Table 5: Initial kinesiological examination- Goniometry. Upper Extremity (shoulder, elbow and wrist joint)

Upper extremities- Hand					
	SFTR	Left		Right	
		AROM	PROM	AROM	PROM
MCP 1	S	30-0-75	40-0-80	30-0-70	35-0-85
	F	30-0-25	30-0-40	30-0-25	30-0-40
MCP2	S	30-0-80	40-0-85	35-0-80	45-0-85
	F	30-0-30	35-0- 40	30-0-30	35-0- 45
MCP3	S	30-0- 80	35-0-90	30-0-80	35-0-90
	F	25-0-35	30-0-40	25-0-40	30-0-40
MCP 4	S	30-0-90	35-0-100	10-0-90	15-0-100
	F	15-0-30	20-0-40	15-0-30	20-0-45
MCP 5	S	30-0-90	35 -0-95	30-0-85	35 -0-90
	F	25-0-50	30-0-60	25-0-40	30-0-45
PIP2	S	0-0- 85	10-0- 95	0-0- 85	10-0- 95
PIP3	S	0-0- 95	10-0- 100	0-0- 95	10-0- 100
PIP4	S	0-0- 90	10-0- 95	0-0- 90	10-0- 95
PIP5	S	0-0- 90	15- 0-100	0-0- 90	0- 0- 95
DIP 2	S	0-0-0	0-0- 45	0-0-0	0-0- 50
DIP3	S	0-0-0	0-0-45	0-0-0	0-0-45
DIP4	S	0-0-0	0-0-55	0-0-0	0-0-60

DIP4	S	0-0-0	0-0- 70	0-0-0	0-0- 75
CMC	S	25-0- 35	45-0- 55	25-0- 35	45-0- 50
	F	70-0- 45	50-0- 25	70-0- 40	50-0- 25
IP-thumb	S	0-0-90	0-0-90	0-0-90	0-0-90

Table 6: Initial kinesiological examination- Goniometry. Upper Extremity (hand)

3.3.4 Muscle length test according to Kendall and Janda

Author	Testing	Left	Right
Janda	Ankle plantar flexors	Grade 1(slight shortnes of soleus)	Grade 0
Kendall	Hip flexors	x	x
Janda	Adductors	Grade 0	Grade 0
Janda	Piriformis	Grade 1	Grade 0
Kendall	Hamstrings	Marked shortness	Morerate shortness
Janda	Quadratus lumborum	x	x
Kendall	Pectoralis major- lower (sternal) part	Moderate shortness- joint pain	Marked shortness
Kendall	Pectoralis major- upper (clavicular) part	Slight shortness	Slight shortness
Kendall	Pectoralis minor	Slight shortness	Slight shortness
Kendall	Teres major, latissimus dorsi, romboid major and minor	Marked shortness- joint pain	Moderate shortness
Kendall	Lateral shoulder rotators	Slight shortness	No shortness
Kendall	Medial shoulder rotators	No shortness	No shortness
Janda	Cranial part of trapezius	Grade 2	Grade 2
Janda	Levator scapulae	Grade 2	Grade 1
Janda	SCM	Grade 1	Grade 2

Janda	Scalene	Grade 1	Grade1

Table 7: Initial kinesiological examination- Muscle length test

Second part of initial KE.

3.3.5 Anthropometric Measurements

Upper extremities athropometry	Left	Right
Length of whole UE	67	67
Length of humerus	28	28
Length of forearm	24	24
Length of hand	15	15

Table 8: Initial kinesiological examination- Anthropometric Measurements.Upper extremity (in cm)

Upper extremities circimferences	Left	Right
Upper arm	29	30
Forearm	25	25
Wrist	17	17,5
Metacarpal bones	19	19,5

Table 9: Initial kinesiological examination- circimferences .Upper extremity (in cm)

Lower extremities athropometry	Left	Right
Anatomical length	80	80
Functional length	76	76
Length of thigh	36	36
Length of middle leg	39	39
Length of foot	24	24

Table 10: Initial kinesiological examination- Anthropometric Measurements. Lower extremity (in cm)

Lower extremities circumferences	Left	Right
Thigh (15cm above patella)	55	56
Knee joint (patella)	39	39
Calf	35	35
Ankle	26	26
Foot	23	23

Table 11: Initial kinesiological examination- circimferences .Lower extremity (in cm)

3.3.6 Fascia examination

	Left	Right
Deep lumbar fascia- caudally	x	x
Dorsal fascia- cranially	x	x
Lateral fascia of the trunk	x	x
Fascia around the thorax- laterally	Hard barrier	Hard barrier
Neck fascia	Hard barrier	Normal barrier
Pectoral fascia	Hard barrier in all directions	Hard barrier in all directions
Plantar fascia	Normal barrier	Normal barrier
Fascia of the thigh (anterior side)	Normal barrier	Slightly restricted barrier
Fascia of the thigh (posterior side)	x	x
Calf fascia	Normal barrier	Slightly restricted barrier

Table 12: Initial kinesiological examination- Fascia examination

3.3.7 Examination of muscle tone

Upper extremity	Left	Right	Position
Levator scapule	x	x	x
Trapezius	Hypertonic in upper part	Hypertonic in upper part	Supine
Supraspinatus	x	x	x
Infraspinatus	x	x	x
Pectoralis major	Hypertonic	Hypertonic	Supine
Pectoralis minor	Hypertonic	Slightly hypertonic	Supine
Latissimus dorsi	x	x	x
Anterior deltoid	Hypotonic	Hypotonic	Supine
Middle deltoid	Normal muscle tone	Normal muscle tone	Supine
Posterior deltoid	Hypotonic	Hypotonic	Supine
Biceps brachii	Hypotonic	Normal muscle tone	Supine
Triceps brachii	Hypotonic	Hypotonic	Supine
Brachioradialis	Normal muscle tone	Normal muscle tone	Supine

Table 13: Initial kinesiological examination- Examination of muscle tone. Upper extremity

Lower extremities	Left	Right	Position
Gluteus Maximus	x	x	x
Biceps femoris	x	x	x
Semitendinosus	x	x	x
Semimembranosus	x	x	x
Rectus femoris	Normal muscle tone	Normal muscle tone	Supine
Vastus medialis	Hypotonic	Hypotonic	Supine
Vastus lateralis	Hypotonic	Normal muscle tone	Supine

Tibialis anterior	Normal muscle tone	Normal muscle tone	Supine
Gastrocnemius-medial	Normal muscle tone	Normal muscle tone	Supine
Gastrocnemius-lateral	Normal muscle tone	Normal muscle tone	Supine
Piriformis	x	x	x

Table 14: Initial kinesiological examination- Examination of muscle tone. Lower extremity

Trunk and neck	Left	Right	Position
Rectus abdominis	Hypotonic	Hypotonic	Supine
External abdominal oblique	Hypotonic	Hypotonic	Supine
Internal abdominal oblique	Hypotonic	Hypotonic	Supine
Errector spinae	x	x	x
Quadratus lumborum	Normal muscle tone	Normal muscle tone	Supine
Scalenius anterior	Hypertonic	Hypertonic	Supine
Scalenius medius	Hypertonic	Hypertonic	Supine
Scalenius posterior	Hypertonic	Hypertonic	Supine
SCM	Normal muscle tone	Hypertonic	Supine

Table 15: Initial kinesiological examination- Examination of muscle tone. Trunk and neck

3.3.8 Joint play examination according to Lewit

Lower extremities	Left	Right
Metatarsophalangeal (MTP)	Dorsal direction- 1st restricted Ventral direction- 1st, 2nd restricted	Dorsal direction- 1st, 4th restricted Ventral direction- free joint play
Proximal interphalangeal	Dorsal direction- 2nd, 4th restricted Ventral direction- free joint play Laterolateral direction- free joint play	Dorsal direction- 2nd restricted Ventral direction- free joint play Laterolateral direction- free joint play
Distal phalanges	Free joint play	Free joint play
Lisfranc's (tarsometatarsal)	Restricted	Restricted
Chopart's (transverse tarsal)	Restricted	Restricted
Subtalar	Free joint play	Free joint play
Talocrural	Free joint play	Free joint play
Tibiofibular	Dorsal direction- restricted Ventral direction- free joint play	Dorsal direction- restricted Ventral direction-free joint play
Patella	Craniocaudal direction- slight restriction Laterolateral direction- restricted	Craniocaudal direction- slight restriction Laterolateral direction- restricted

Table 16: Initial kinesiological examination- Joint play examination. Lower extremity

Pelvis/SI joint	Left	Right
Ilium against the sacrum- springing test in supine position	Restricted	Free joint play
Rosina test	x	x
Superior part of sacroiliac joint- springing test in prone position	x	x
The 'spine sign' test	x	x

Table 17: Initial kinesiological examination- Joint play examination. Pelvis

Spine	Left	Right
Lumbar spine	Springing test in prone position-x Retroflexion- x Anteflexion- x Side bending- x	Retroflexion- x Anteflexion- x Side bending- x
Thoracic spine	Springing test in prone position-x free joint play Retroflexion- x Anteflexion- x ROT- x Side bending- x	Retroflexion- x Anteflexion- x ROT- x Side bending- x
Cervical spine	Passive mobility- free Active mobility-x	Passive mobility- free Active mobility-x

Spine	Left	Right
Cervical spine- examination of the motion segments	Side bending- free joint play ROT- x Shifting- x	Side bending- free joint play ROT- x Shifting- x
Cervical spine- occiput and atlas	Anteflexion- free joint play Side bending- free joint play Retroflexion- free joint play ROT- x	Anteflexion- free joint play Side bending- free joint play Retroflexion- free joint play ROT- x

Table 18: Initial kinesiological examination- Joint play examination. Spine

Upper extremity and ribs	Left	Right
Distal interphalangeal(DIP)	Dorsal direction- 4th,3rd restricted Ventral direction- 2nd restricted	Dorsal direction- 2nd, 4th restricted Ventral direction- free joint play
Proximal interphalanheal(PIP)	Dorsal direction- 2nd,3rd restricted Ventral direction- free joint play Laterolateral direction- free joint play	Dorsal direction- 2nd restricted Ventral direction- free joint play Laterolateral direction- free joint play
Interphalangeal (IP)- thumb	Dorsal direction- restricted Ventral direction- free joint play	Dorsal direction- restricted Ventral direction- free joint play

Metacarpophalangeal (MCP)	Dorsal direction- 1st,2nd, 3rd restricted Ventral direction- 1st, 2nd restricted	Dorsal direction- 1st,2nd, 3rd restricted Ventral direction- 1st, 2nd, 5th restricted
Carpometararpal (CMC)	Free joint play	Free joint play
Individual carpal bones	Capitate/lunate- restricted	Free joint play
Radiocarpal	Free joint play	Free joint play
Proximal row of carpal bones	Restricted	Free joint play
Distal row of carpal bones	Free joint play	Free joint play
Elbow- radial direction	x	x
Elbow- ulnar direction	x	x
Shoulder joint	x	x
Acromioclavicular	Dorsal direction- restricted Ventral direction- restricted	Dorsal direction- restricted Ventral direction- free joint play
Sternoclavicular	Restricted	Restricted
Movement of the scapula against the trunk	x	x
Ribs (supine position)	Inhalation- 2nd,3rd,4th restricted Exhalation- 2nd,3rd restricted	Inhalation- 3rd restricted Exhalation- 2nd restricted
1st rib	x	x

Table 19: Initial kinesiological examination- Joint play examination. Upper extremity.
x- examination wasn't possible to provide

3.3.9 Conclusion

After providing an initial kinesiological examination I can conclude that the patient's condition is mostly affected by factors which I can divide into two groups.

First of all, pneumonia severely affected her lungs, while COVID-19 became an

aggravating factor for it. Patients' breathing pattern is mostly concentrated in the abdominal area as a compensatory mechanism for damaged lungs. Since the left lung is more affected, its almost not showing any movement in ventro-dorsal direction. Pathological accompanying sounds in both lungs arise due to fibrosis, and because the left lung almost not functioning, I can hear more sounds in the right lung.As the result of pathological breathing pattern, other surrounding structures are also affected. Joint play of sternoclavicular, acromioclavicular joints is restricted in both directions, same as 2nd, 3rd, 4th ribs in inhalation and exhalation.

Scalene, SCM, levator scapulae, cranial part of trapezius, pectoralis major and minor are shortened, at the same time pectoralis major and minor muscles are hypertonic and pectoral fascias are restricted by a hard barrier.

Muscle tone is generally increased in the upper part of the trunk and neck area, it can be explained by excessive muscle activation given by pathological breathing pattern. However, muscles of the abdominal area are hypotonic, which indicates the weakness of the deep stabilization system.

The second crucial factor, a patient has to spend all the time in her bed without the ability to walk and sometimes even to sit without external support because of her excessive tiredness and weakness. As the result, we can see slight joint mobility limitations, joint play restrictions especially in lower extremities, and fascia barrier restrictions.

Goniometry results represent decreased ROM in the left shoulder joint in FLX and ABD, the patient feels stiffness in the joint but no pain. Taking a look at the X-Ray picture, the patient has slight dislocation of the humeral head, it could be the reason for decreased ROM. Additionally patient has decreased ROM in the wrist joint in FLX and EXT on the left hand given by the catheter. During the anthropometric measurements, no length or circumferences differences in extremities were found.

According to neurological examination, no pathological changes were found, the only important note, the patient has decreased deep tendon reflexes but the results are almost similar on both sides of the body so these changes could occur due to the pharmacological drugs.

Examinations have been done within 2 days due to the patient condition, and I have pay attention to a fact that during the first day were provided: examination of the breathing pattern, neurological examination, goniometry, and muscle length test, at this time patient, was tired but she was able to cooperate. However send part of the examination which included anthropometry, fascia examination, muscle tone palpation, and joint play mobilization had to be provided when the patient was already in an induced coma. Some results from the second part of the initial KE are not accurate because the patient was in an induced coma under the influence of pharmaceutic drugs.

According to this, I'm not able to say if the patient had any pain when the second part of the initial kinesiological examination was provided. Nonetheless during the first part of the examination patient didn't complain about any pain, except difficulties to breath and slight joint stiffness given by prolonged lying position. All examinations were provided in a supine position due to the patient's condition.

3.4.The goal of a short-term rehabilitation plan

- correction of the breathing pattern
- improve lung ventilation
- restore normal joint play on restricted joints
- decrease hypertonus in affected muscles especially pectoralis major and minor, upper part of trapezius and SCM
- maintain ROM in hip, knee, ankle, elbow and wrist joints
- increase ROM in shoulder joint
- increase the length of shortened muscles
- restore soft barrier of fascias
- prevent joint stiffness
- transition into sitting position
- verticalization
-TE prevention

3.4.1.Therapy proposal for a short-term plan

- respiratory exercises for better lung ventilation and increasing of saturation level
- ability to breathe normally without assistive aids
- manual methods according to Lewit to mobilize restricted joints
- STT and massage for hypertonic muscles
- passive (semi-active) movements to maintain and increase ROM
- passive stretching for shortened muscles
- fascia stretching technique according to Lewit
- passive movements for joint stiffness prevention, better blood circulation, muscle atrophy, degenerative changes
- exercises for TE prevention

3.5 The goal of long-term rehabilitation plan

-improve the general physical condition of the patient
- possibility to walk without external support
- improve stability
- get as close as possible to optimal lung function
- reduce weight
- add more activities to life such as nordic walking, swimming etc.

3.5.1 Therapy proposal for a long-term rehabilitation plan

- continue with breathing exercises
- strengthening for DSS
- muscle strengthening using PNF technique, therabands and own weight
- balance exercises to increase stability
- exercises to increase stability
- patient education

3.6 Day to day therapies

3.6.1 First therapeutic unit (22.1.21)

The patient had the therapy for the first time with me. Taking anamnesis and providing the first half of the initial kinesiological examination took the length almost of the whole session.

Subjective:

The patient feels week, but she is well cooperative and orientated. She complaining about difficulties to breath and chest tightness, but no other limitations or pain.

Objective:

The patient has a respiratory mask with an increase level of oxygen. Her breathing is regular with a ratio 1/1, chest movement in dorso-ventral direction on the right side is decreased, while on the left side almost absent. Chest vibration with slight accompanying sounds during inhalation on both sides, more on the right side. The lower part of the chest is not expanding laterally properly.

Blood pressure: 140/100
Saturation level: 85%
Heart rate: 90/min

The goal of today's unit:
- Provide anamnesis and the first part of the initial kinesiological examination
- Educate patient for TE prevention techniques
- Education for breathing exercises

Therapy proposal:

- Respiratory therapy
- TE prevention exercises for UE and LE

Procedures:

1. Taking the anamnesis
2. Initial kinesiological examination
3. Respiratory therapy for increasing of saturation level and improving respiratory function, deep breathing
4. TE prevention exercises

Subjective results:

The patient was educated for breathing exercises, for the beginning she has to try to breathe more deeply, however, she needs more time to learn how to do it properly, still it's very difficult for her.

Objective results:

Anamnesis and initial kinesiological examination were provided.

The saturation level increased by 1%. The exhalation period was slightly prolonged.

Self-therapy:

Deep breathing and TE prevention exercises for UE and LE 2x day.

3.6.2 Second therapeutic unit (25.1.21)

Subjective:

The patient's condition gets worse and was required for mechanical ventilation, doctors indicated her an medically induced coma for an indefinite period as a prevention of future complications and better support of life functions.

Objective:

The patient has an invasive ventilation for life function support. The breathing stereotype is similar compared to yesterday.

Blood pressure: 135/100

Saturation level: 85%

Heart rate: 90/min

The goal of today's unit:

- Provide second part of the initial kinesiological examination
- Improve lung ventilation
- Increase saturation level

Therapy proposal:

- Respiratory therapy

Procedures:

1. Initial kinesiological examination
2. Contact breathing techniques using vibration for exhalation phase for better lung ventilation and increasing the saturation level.

Subjective results:

Subjective results cant be evaluated.

Objective results:

The second part of the initial kinesiological examination was provided.

The saturation level increased by 1%. The exhalation period was slightly prolonged.

Self-therapy:

Self-therapy can't be given.

3.6.3 Third therapeutic unit (26.1.21).

Subjective:

Subjective can't be evaluated.

Objective:

The first day in a medically induced coma. The patient has an invasive ventilation for life functions support. The breathing stereotype is similar comparing to yesterday, but chest vibration feels less on the right side.

Blood pressure: 135/95
Saturation level: 85%
Heart rate: 83/min

The goal of today's unit:
- Relax hypertonic muscles
- Restore normal fascia barrier
- Joint mobilization
- Maintaining joint flexibility
- Improve lung ventilation
- Increase saturation level

Therapy proposal:
- Respiratory therapy
- STT to decrease muscle hypertone

- Joint mobilizations according to Lewit
- Passive movements
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing techniques for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation, and increasing of the saturation level.

2. STT to decrease hypertone of:
- upper part of trapezius on both sides
- pectoralis major on both sides
- pectoralis minor on both sides
- scalenus anterior, medius and posterior on both sides
- SCM on the right side.

3. Fascia releasing techniques according to Lewit for :
- fascia around the thorax on both sides
- neck fascia on left side
- pectoral fascia in all directions on both sides.

4. Passive movements:
- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

5. Joint mobilizations according to Lewit:

- acromioclavicular joint: dorsal and ventral direction on the left side, dorsal direction on the right side
- sternoclavicular joint on both sides
- ribs: 2nd, 3rd, 4th on the left side in inhalation, 3rd on the right side in inhalation. 2Nd and 3rd ribs in exhalation on the left side, 2nd in exhalation on the right side

6. Preventive repositioning.

The general goals of preventive repositioning:

- prevention of muscle atrophy and contractures
- prevention of restriction in ROM
- improvement in circulatory functions
- prevention of joint deformations
- prevention of pressure sores
- prevention of damage of peripheral nerves
- elimination of pain

The patient's position was changes supine to semisupinated position for better lung ventilation.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- Saturation level increased by 1%
- The exhalation and inhalation period was slightly prolonged
- Muscle tension of trapezius on both sides, pectoralis major and minor on both sides, and SCM on the right side is slightly decreased, however its still in high tension
- Pectoral fascia on both sides have slightly less restricted barrier
- Joint play of acromioclavicular joint in ventral and dorsal direction is slightly less

restricted on both sides, sternoclavicular joint is less restricted on the right side

Self-therapy:

Self-therapy can't be given.

3.6.4 Fourth therapeutic unit (27.1.21)

Subjective:

Subjective can't be evaluated.

Objective:

The second day in a medically induced coma. The breathing wave is superficial, the breathing wave in the upper and middle thoracic regions is very low. Pathological vibration is observed more than previously on both sides mostly in the inhalation stage but also in exhalation. The lower part of the chest is not expanding laterally and dorsally at all on both sides.

Blood pressure: 140/85
Saturation level: 83%
Heart rate: 80/min

The goal of today's unit:

- Improve lung ventilation
- Increase saturation level
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier
- Joint mobilization

- Maintaining joint flexibility

Therapy proposal:

- Respiratory therapy
- STT to decrease muscle hypertone
- passive stretching
- Joint mobilizations according to Lewit
- Passive movements
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level. After the respiratory therapy, suctioning was provided by the nurses to clear excessive lower respiratory tract secretions such as pus.

2. STT to decrease hypertone of:

- upper part of trapezius on both sides
- pectoralis major on both sides
- pectoralis minor on both sides
- scalenus anterior, medius and posterior on both sides
- SCM on the right side.

3. Passive stretching of:

- Pectoralis major- lower (sternal) part on both sides
- Pectoralis major- upper (clavicular) part on both sides
- Pectoralis minor on both sides
- Teres major, latissimus dorsi, romboid major and minor on both sides
- Lateral shoulder rotators on the left side

- Cranial part of trapezius
- Levator scapulae
- SCM
- Scalene

4. Fascia releasing techniques according to Lewit for :
- fascia around the thorax on both sides
- neck fascia on the left side (in supine position)
- pectoral fascia in all directions on both sides.

5. Passive movements:
- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

6. Joint mobilizations according to Levit:
- acromioclavicular joint: dorsal and ventral direction on the left side, dorsal direction on the right side
- sternoclavicular joint on both sides
- ribs: 2nd, 3rd, 4th on the left side in inhalation, 3rd on the right side in inhalation. 2nd and 3rd ribs in exhalation on the left side, 2nd in exhalation on the right side

7. Preventive repositioning.

The patient's position was changed from supine to semisupinated position for better lung ventilation.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 3% after the respiratory physiotherapy and suctioning procedure
- The lower part of the chest is expanding laterally more than before the treatment, breathing wave in the middle thoracic region is slightly increased
- The exhalation and inhalation period was slightly prolonged
- Muscle tension SCM and scalene is visibly decreased after the STT and stretching
- Pectoralis major and minor muscles are in less tension comparing to yesterday's therapy, its length increased after the passive stretching, pectoral fascia now is free on the left side and less restricted on the right, so the combination of STT, passive stretching and fascia releasing techniques is more effective for the patient
- Upper part of trapezius on both sides is still in high tension even after the therapy, the patient tends to elevate her shoulders during the inhalation
- The joint play of the ribs is still very restricted, since the patient cant cooperate, which makes the therapy more difficult
- Joint play of acromioclavicular joint in ventral and dorsal direction is free on both sides, sternoclavicular joint is less restricted on both sides

Self-therapy:

Self-therapy can't be given.

3.6.5 Fifth therapeutic unit (28.1.21)

Subjective:

Subjective can't be evaluated.

Objective:

The third day in a medically induced coma. The breathing wave still superficial, but the ventro-dorsal movement in the upper thoracic region slightly increased. During the palpation, pathological vibration is more observed on the right side and a little bit on the left in inhalation, no vibration in the exhalation period. The lower part of the chest is slightly expanding laterally and dorsally on the right side.

Blood pressure: 130/80
Saturation level: 85%
Heart rate: 78/min

The goal of today's unit:
- Improve lung ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier
- Joint mobilization
- Maintain and increase ROM

Therapy proposal:
- Respiratory therapy
- Passive movements
- Joint mobilizations according to Lewit
- Massage to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level.

2. Passive movements:

- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

3. Joint mobilizations according to Lewit:

- ribs: 2nd, 3rd, 4th on the left side in inhalation, 3rd on the right side in inhalation. 2nd and 3rd ribs in exhalation on the left side, 2nd in exhalation on the right side
- sternoclavicular joint on both sides
- Proximal row of carpal bones on the left UE
- Individual carpal bones (capitate/lunate) on the left UE
- Metacarpophalangeal (MCP) joints on both hands
- Interphalangeal (IP) joint on both hands
- Proximal interphalangeal(PIP) joint on both hands
- Distal interphalangeal(DIP) joint on both hands

4. Massage to decrease muscle tension of:

- upper part of trapezius on both sides
- pectoralis major on both sides
- pectoralis minor on both sides
- scalenus anterior, medius and posterior on both sides
- SCM on the right side.

5. Passive stretching of:

- Pectoralis major- lower (sternal) part on both sides
- Pectoralis major- upper (clavicular) part on both sides
- Pectoralis minor on both sides
- Teres major, latissimus dorsi, romboid major and minor on both sides
- Lateral shoulder rotators on the left side
- Cranial part of trapezius
- Levator scapulae
- SCM
- Scalene

6. Fascia releasing techniques according to Lewit for :

- fascia around the thorax on both sides
- neck fascia on the left side (in supine position)
- pectoral fascia in all directions on both sides.

7. Preventive repositioning.

The patient's position was changed from supine to semireclined position for better lung ventilation.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 1% after the respiratory physiotherapy
- The lower part of the chest is expanding laterally more on the right side than before the treatment, breathing wave in the upper in the middle thoracic region is slightly increased
- The exhalation and inhalation period was slightly prolonged

- Muscle tension of the SCM is visibly decreased after the massage and stretching
- Scalenus anterior, medius and posterior on both sides are in normal muscle tone after the treatments
- Pectoralis major and minor muscles are in less tension comparing to yesterday's therapy, its length increased after the passive stretching but still, the limitation in ROM of the left shoulder limits the stretching, pectoral fascia now is less restricted on the right side
- Upper part of trapezius is in less tension after the therapy.
- The patient tends to elevate her shoulders during the inhalation little bit less than yesterday
- The joint play of the 3rd rib on the right side in the inhalation phase is free, 2nd and 3rd ribs in exhalation on the left side are less restricted, 2nd rib in exhalation on the right side is less restricted. The ribs were possible to mobilize after the STT and stretching, it illustrates the effectiveness of the therapy, but still, the left side is more restricted because the left lung is functioning very badly.
- The joint play of the sternoclavicular joint is free on both sides, the proximal row of carpal bones on the left hand is free, capitate/lunate is free on the left hand. MCP, IP, PIP and DIP joints are free on both UE.
- The ROM of the elbow and wrist joints is increased by 10d degrees on both hands.
- During the passive movements patient tended to slightly activate the muscles in UE on both UE. According to this, I'm planning to try the PNF diagonals for UE tomorrow.

Self-therapy:

Self-therapy can't be given.

3.6.6 Sixth therapeutic unit (29.1.21)

Subjective:

Subjective can't be evaluated.

Objective:

The fourth day in a medically induced coma. The ventro-dorsal movement in the upper and middle thoracic region is slightly increased after yesterday's therapy but still, it's not optimal. During the palpation, pathological vibration is slightly observed on the right side and less on the left in inhalation, no vibration in the exhalation period similar to yesterday. The lower part of the chest is slightly expanding laterally and dorsally on the right side, with no movement on the left.

Blood pressure: 130/90
Saturation level: 85%
Heart rate: 75/min

The goal of today's unit:
- Improve lung ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Provoke muscle activation by PNF
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier
- Joint mobilization

Therapy proposal:
- Respiratory therapy
- PNF
- Joint mobilizations according to Lewit
- Massage to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level.

2. PNF for UE:

- 1st FLX
- 1st EXT
- 2nd FLX
- 2nd EXT

3. Joint mobilizations according to Lewit:

- ribs: 2nd, 3rd, 4th on the left side in inhalation
- 2nd rib in exhalation on the right side

4. Massage to decrease muscle tension of:

- upper part of trapezius on both sides
- pectoralis major on both sides
- pectoralis minor on both sides
- SCM on the right side

5. Passive stretching of:

- Pectoralis major- lower (sternal) part on both sides
- Pectoralis major- upper (clavicular) part on both sides
- Pectoralis minor on both sides
- Teres major, latissimus dorsi, romboid major and minor on both sides
- Lateral shoulder rotators on the left side
- Cranial part of trapezius
- Levator scapulae
- SCM

6. Fascia releasing techniques according to Lewit for :

- fascia around the thorax on both sides
- neck fascia on the left side (in supine position)
- pectoral fascia in all directions on both sides.

7. Preventive repositioning.

The patient's position was changed from semireclined position to supine for the treatment, the patient stayed in supine position.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 1% after the respiratory physiotherapy
- The lower part of the chest is expanding laterally more on the right side than before the treatment, breathing wave in the upper in the middle thoracic region is slightly increased
- The exhalation and inhalation period was slightly prolonged
- Muscle tension of the SCM and upper part of trapezius is decreased after the massage and stretching
- Pectoralis major on the right side is not shortened, normal fascia barrier is restored, on the left side it's in higher tension, it will need more therapies to relax and stretch the muscle
- Pectoralis minor on both sides is in less tension after the therapies
- The patient tends sometimes to elevate her shoulders in the inhalation period but less frequently than before.
- The joint play of the ribs on the left side is slightly restricted
- During the PNF diagonals provided on the upper extremities, I was communicating with the patient and gave her the instructions. She was slightly activating wrist and finger flexors on the right hand.

Self-therapy:

Self-therapy can't be given.

3.6.7 Seventh therapeutic unit (1.2.21)

Subjective:

Subjective can't be evaluated.

Objective:

The seventh day in a medically induced coma. The breathing wave is more superficial than after the last session, the breathing wave in the upper and middle thoracic regions is very low. Pathological vibration is observed more than previously on both sides mostly in the inhalation period, especially on the rigth. The lower part of the chest is not expanding laterally and dorsally at all on both sides.

Blood pressure: 140/100

Saturation level: 82%

Heart rate: 80/min

The goal of today's unit:

- Improve lung ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Provoke muscle activation by PNF
- Maintain and increase ROM
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier

- Joint mobilization

Therapy proposal:

- Respiratory therapy
- PNF
- Passive movements
- Joint mobilizations according to Lewit
- STT to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level. After the respiratory therapy, suctioning was provided by the nurses to clear excessive lower respiratory tract secretions.

2. Passive movements:

- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

3. PNF for UE:

- 1st FLX
- 1st EXT
- 2nd FLX

- 2nd EXT

4. Joint mobilizations according to Lewit:

- ribs: 2nd, 3rd, 4th on the left side in inhalation
- 2nd rib in exhalation on the right side
- SI joint on the left side
- Patella in craniocaudal and laterolateral directions on both LE
- Tibiofibular joint in dorsal direction on both LE
- Chopart's joint on both LE
- Lisfranc's joint on both LE
- Proximal interphalangeal joints in dorsal and ventral directions on both LE
- Metatarsophalangeal (MTP) joints in dorsal and ventral directions on both LE

5. STT to decrease muscle tension of:

- upper part of trapezius on both sides
- pectoralis major on both sides
- pectoralis minor on both sides
- SCM on the right side

6. Passive stretching of:

- Pectoralis major- lower (sternal) part on the left side
- Pectoralis major- upper (clavicular) part on ther left side
- Pectoralis minor on both sides
- Lateral shoulder rotators on the left side
- Cranial part of trapezius
- Levator scapulae
- SCM
- Ankle plantar flexors on the left LE
- Hamstrings on both LE

7. Fascia releasing techniques according to Lewit for :

- Fascia around the thorax on both sides
- Neck fascia on the left side (in supine position)
- Pectoral fascia on the left side
- Fascia of the thigh on the right LE
- Calf fascia on the right LE

8. Preventive repositioning.

The patient's position was changed from supine position to semisupinated.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 4% after the respiratory physiotherapy and suctioning treatment, the patient's airways get a lot of excessive secretions throughout the weekend, after the therapy breathing is more clear.
- The exhalation and inhalation period was slightly prolonged
- The lower part of the chest is expanding laterally more on the right side than before the treatment, however not on the left side, the trunk fascia is still very restricted
- Breathing wave in the upper in the middle thoracic region is increased on the right side
- The tension of the upper part of trapezius is decreased after the STT and stretching
- Muscle tension of the SCM and pectoralis major on the left side normal now and the muscle is not shortened on both sides
- The neck fascia barrier is free, its limitation could be connected with very shortened muscles of the neck which are relaxed now after the therapies
- Pectoralis minor on both sides is in less tension after the therapies
- The joint play of the ribs on the left side was more restricted comparing to the last session before the weekend but it was less restricted after the applied therapy
- The joint play of the SI joint on the left side, Chopart's and Lisfranc's joints on both

LE, patella in craniocaudal direction on both LE, PIP and MTP joints in dorsal and ventral directions on both LE are free

- The joint play of the patella in laterolateral direction on both LE is less restricted, tibiofibular joint in dorsal direction on both LE is less restricted
- The thigh and calf fascia on the right LE is less restricted
- The muscle length of lateral shoulder rotators on the left side and levator scapulae is normal after the passive stretching
- The muscle length of hamstrings on both LE is increased, ankle plantar flexors on the left LE are not shortened
- Fascia around the thorax is less restricted on the right side
- During the PNF diagonals provided on the upper extremities, I was communicating with the patient and gave her the instructions same as previously. The patient was slightly activating wrist flexors on both hands.

Self-therapy:

Self-therapy can't be given.

3.6.8 Eighth therapeutic unit (2.2.21)

Subjective:

Subjective can't be evaluated.

Objective:

The eighth day in a medically induced coma. After yesterday's treatment and suctioning procedure the pathological vibration is decreased. The lower part of the chest is slightly expanding laterally on the right side, with no movement on the left side. The breathing wave is still superficial, the breathing wave in the upper and middle thoracic regions is low on the right side and almost absent on the left.

Blood pressure: 140/100

Saturation level: 85%

Heart rate: 85/min

The goal of today's unit:

- Improve airway clearance and ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Provoke muscle activation by PNF
- Maintain and increase ROM
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier
- Joint mobilization

Therapy proposal:

- Respiratory therapy
- PNF
- Passive movements
- Joint mobilizations according to Lewit
- STT to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level.

2. Passive movements:

- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

3. PNF for UE:
- 1st FLX
- 1st EXT
- 2nd FLX
- 2nd EXT

4. Joint mobilizations according to Lewit:
- ribs: 2nd, 3rd, 4th on the left side in inhalation
- 2nd rib in exhalation on the right side
- Patella in craniocaudal direction on both LE
- Tibiofibular joint in dorsal direction on both LE

5. STT to decrease muscle tension of:
- upper part of trapezius on both sides
- pectoralis minor on both sides

6. Passive stretching of:
- Pectoralis major- lower (sternal) part on the left side
- Pectoralis major- upper (clavicular) part on the left side
- Pectoralis minor on both sides
- Cranial part of trapezius
- Hamstrings on both LE

7. Fascia releasing techniques according to Lewit for :

- Fascia around the thorax on both sides
- Pectoral fascia on the left side
- Fascia of the thigh on the right LE
- Calf fascia on the right LE

8. Preventive repositioning.

The patient's position was changed from supine position to semisupinated.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 1% after the respiratory physiotherapy
- The exhalation and inhalation period was slightly prolonged
- The lower part of the chest is expanding laterally more on the right side than before the treatment, however not on the left side
- Breathing wave in the upper in the middle thoracic region is increased on the right side
- Pectoralis minor on both sides is not shortened
- The tension of the upper part of trapezius is decreased after the STT and stretching
- The ROM of the left shoulder joint slowly increasing after the therapies at 10 degrees
- The joint play of the patella in laterolateral direction on both LE and tibiofibular joint in dorsal direction on both LE is free
- The thigh and calf fascia on the right LE is free
- The muscle length of hamstrings on both LE is increased
- During the PNF the patient slightly activated wrist flexors on both hands in the 1st FLX diagonal a few times

Self-therapy:

Self-therapy can't be given.

3.6.9 Ninth therapeutic unit (3.2.21)

Subjective:

Subjective can't be evaluated.

Objective:

The ninth day in a medically induced coma. The breathing wave is more superficial again comparing to yesterday, the breathing wave in the upper and middle thoracic regions on the right side is very low and absent on the left side. Pathological vibration is observed mostly on the right side in the inhalation period. The lower part of the chest is not expanding laterally and dorsally on both sides. The patient tends to elevate her shoulders more comparing to previous sessions.

Blood pressure: 125/95
Saturation level: 82%
Heart rate: 90/min

The goal of today's unit:
- Improve airway clearance and ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Maintain ROM
- Relax hypertonic muscles
- Increase the length of shorted muscles
- Restore normal fascia barrier
- Joint mobilization

Therapy proposal:

- Respiratory therapy
- Passive movements
- Joint mobilizations according to Lewit
- STT to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:

1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level. After the respiratory therapy, the suctioning procedure was provided by the nurses to clear excessive lower respiratory tract secretions.

2. Passive movements:
- ankle joint plantarFLX and dorsiFLX
- knee FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

4. Joint mobilizations according to Lewit:
- ribs: 2nd, 3rd, 4th on the left side in inhalation
- 2nd rib in exhalation on the right side

5. Massage to decrease muscle tension of:
- upper part of trapezius on both sides
- pectoralis minor on both sides

6. Passive stretching of:

- Pectoralis major- lower (sternal) part on the left side
- Pectoralis major- upper (clavicular) part on the left side
- Cranial part of trapezius

7. Fascia releasing techniques according to Lewit for :

- Fascia around the thorax on both sides
- Pectoral fascia on the left side

8. Preventive repositioning.

The patient's position was changed from supine position to semireclined.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 3% after the respiratory physiotherapy and suctioning procedure
- The exhalation and inhalation period was slightly prolonged by the therapy
- The lower part of the chest is expanding laterally more on the right side than before the treatment
- Breathing wave in the upper in the middle thoracic regions is increased on the right side and began to be slightly visible on the left side
- The joint play of the 2nd rib in exhalation on the right side is free
- The tension of the upper part of trapezius was higher than usual before the treatment, it can be explained by the shoulder elevation during inhalation, but after the massage in combination with passive stretching its tension decreased
- Fascia around the thorax is free on the right side and less restricted on the left side

Self-therapy:

Self-therapy can't be given.

3.6.10 Tenth therapeutic unit (4.2.21)

Subjective:

Subjective can't be evaluated.

Objective:

The tenth day in a medically induced coma. The ventro-dorsal movement in the upper and middle thoracic region is slightly increased after yesterday's therapy on the right side.

During the palpation, pathological vibration is observed on the right side and less on the left in inhalation, with no vibration in the exhalation period. The lower part of the chest is slightly expanding laterally and dorsally on the right side, with no movement on the left. The patient tends to elevate her shoulders slightly more than after yesterday's therapy.

Blood pressure: 140/100

Saturation level: 84%

Heart rate: 88/min

The goal of today's unit:

- Improve airway clearance and ventilation
- Increase saturation level
- Prolongation of the inhalation and exhalation period
- Maintain ROM
- Relax hypertonic muscles
- Increase the length of shorted muscles

- Restore normal fascia barrier
- Joint mobilization

Therapy proposal:
- Respiratory therapy
- Passive movements
- Joint mobilizations according to Lewit
- STT to decrease muscle hyper tone
- Passive stretching
- Fascia releasing techniques according to Lewit
- Repositioning

Procedures:
1. Contact breathing technique for prolongation of inhalation phase, contact vibration for exhalation phase for better lung ventilation and increasing of the saturation level.

2. Passive movements:
- ankle joint plantarFLX and dorsiFLX
- knee joint FLX and EXT
- hip joint FLX
- wrist joint FLX, EXT, supination, pronation, ulnar and radial duction
- elbow joint FLX and EXT
- shoulder joint FLX, ABD, horizontal ADD

4. Joint mobilizations according to Levit:
- ribs: 2nd, 3rd, 4th on the left side in inhalation

5. Massage to decrease muscle tension of:
- upper part of trapezius on both sides
- pectoralis minor on both sides

6. Passive stretching of:

- Pectoralis major- lower (sternal) part on the left side
- Pectoralis major- upper (clavicular) part on the left side
- Cranial part of trapezius

7. Fascia releasing techniques according to Lewit for :

- Fascia around the thorax on both sides
- Pectoral fascia on the left side

8. Preventive repositioning.

The patient's position was changed from semireclined to supine.

Subjective results:

Subjective results cant be evaluated.

Objective results:

- The saturation level increased by 2% after the respiratory physiotherapy
- The exhalation and inhalation period was slightly prolonged by the therapy
- The lower part of the chest is expanding laterally more on the right side than before the treatment
- Breathing wave in the upper in the middle thoracic regions is increased
- Pectoralis major is not shortened on the left side
- The tension of the upper part of trapezius is decreased
- The ROM of all mobilized joints is slightly increased
- Fascia around the thorax is free on the right side and less restricted on both sides

Self-therapy:

Self-therapy can't be given.

3.6.11 Eleventh therapeutic unit (5.2.21)

Subjective:

-

Objective:

Today morning tracheostomy was provided, it can help the future rehabilitation process. The doctors decided to slowly wake the patient up from an induced coma, level of sedative drugs was decreased. Due to the recent surgery, the physiotherapeutic unit cant be provided.

The goal of today's unit:

-

Therapy proposal:

-

Procedures:

-

Subjective results:

-

Objective results:

-

Self-therapy:

-

3.7 Final kinesiological examination

Unfortunately, 7.2 (Sunday) the patient died because of acute respiratory failure and respiratory arrest. The final kinesiological examination could not be carried out.

3.8 Evaluation of the therapy

In order to determine the effectiveness of the therapy, the results and information about the therapeutic units that were carried out during the entire time of work with the patient are presented below.

3.8.1.Examination of breathing pattern

In supine position patient's breathing was still mostly concentrated in the abdominal area, a slight breathing wave in the upper, middle, and lower thoracic regions was visible but only on the right side. In the upper and middle thoracic regions chest movement in dorso-ventral direction is decreased on the right side and absent on the left side. During the respiratory therapy slight movement on the left side was present but for a very short period. The breathing wave is regular but superficial, due to the severe damage of the left lung the patient wasn't able to take a deep breath. During chest palpation, pathological vibration was observed in the inhalation stage with slight accompanying sounds in the upper and middle thoracic regions on the right side. The lower part of the chest didn't expand laterally and dorsally on the left side, on the right side only slight expansion was observed. Inhalation was accompanied by slight symmetrical shoulder elevation. Due to the fact that both lungs were severely damaged I could observe a gradual decrease in their function, during the last therapies any movement on the left side in the thoracic region was absent, also movement on the right side decreased. The saturation level always increased after the respiratory physiotherapy especially when it was combined with suctioning procedure which helped to clean the airways but the saturation usually decreased back after few hours.

3.8.2 Neurological examination

According to the initial neurological examination which was provided when the patient was in consciousness, no pathologies were observed. Therefore, the therapy wasn't concentrated on any neurological treatments.

3.8.3 Goniometry according to Kendall

In general, the ROM was in a range of norm at the beginning of the therapy, except for the left shoulder which was limited in ABD and FLX. The goal was to maintain and slightly increase ROM in tested joints to keep it in normal measures.

The following tables are in aim to compare the therapy progression in ROM. The therapeutical improvements are written in bold font. Initial goniometry testing was provided when the patient was in consciousness, the AROM wasn't possible to evaluate later during the therapy.

Lower extremities									
Initial KE						Changes during the therapy			
	SFTR	Left		Right		Left		Right	
		AROM	PROM	AROM	PROM	AROM	PROM	A R O M	PROM
Hip	S	x-0-115	x-0-120	x-0-120	x-0-120	x	**x-0-125**	x	**x-0-130**
	F	35-0-25	40-0-30	35-0-20	40-0-25	x	**40-0-35**	x	**40-0-30**
	R	45-0-30	50-0-35	40-0-35	45-0-40	x	**50-0-40**	x	**50-0-40**
Knee	S	0-0-130	0-0-135	0-0-130	0-0-135	x	0-0-135	x	0-0-135
Ankle	S	5 0 - 0 - 30	50- 0-35	50-0-30	50-0-35	x	**50-0-35**	x	50-0-35
	R	2 0 - 0 - 40	25-0-45	15-0-40	20-0-50	x	**30-0-50**	x	**30-0-50**

Table 20: Comparative table between initial kinesiological examination and changes during the therapy- Goniometry. Lower extremity (hip, knee and ankle joints)

Upper extremities									
Initial KE						Changes during the therapy			
	SFTR	Left		Right		Left		Right	
		AROM	PROM	AROM	PROM	AROM	PROM	AROM	PROM
Shoulder	S	x-0-130	x-0-140	x-0-160	x-0-170	x	**x-0-150**	x	**x-0-175**
	F	x-0-110	x-0-125	x-0-170	x-0-180	x	**x-0-140**	x	x-0-180
	T	x-0-120	x-0-120	x-0-120	x-0-120	x	x-0-120	x	x-0-120
	R	50-0-50	55-0-50	45-0-50	50-0-50	x	55-0-50	x	**55-0-50**
Elbow	S	0-0-130	0-0-135	0-0-130	0-0-135	x	**0-0-135**	x	0-0-135
Wrist	S	50-0-40	50-0-40	70-0-80	75-0-80	x	50-0-40	x	**80-0-80**
	F	15-0-25	15-0-25	20-0-25	20-0-30	x	**20-0-30**	x	**20-0-35**
	R	90-0-90	90-0-90	90-0-90	90-0-90	x	90-0-90	x	90-0-90

Table 21: Comparative table between initial kinesiological examination and changes during the therapy-Goniometry. Upper extremity (shoulder, elbow and wrist joints)

3.8.4.Muscle length test according to Kendall and Janda

The therapeutical improvements are written in bold font.

Author	Testing	Initial KE		Changes during the therapy	
		Left	Right	Left	Right
Janda	Ankle plantar flexors	Grade 1(slight shortnes of soleus)	Grade 0	**Grade 0**	Grade 0
Kendall	Hip flexors	x	x	x	x
Janda	Adductors	Grade 0	Grade 0	Grade 0	Grade 0
Janda	Piriformis	Grade 1	Grade 0	**Grade 0**	Grade 0
Kendall	Hamstrings	Marked shortness	Morerate shortness	**Slight shortness**	**Slight shortness**

Janda	Quadratus lumborum	x	x	x	x
Kendall	Pectoralis major- lower (sternal) part	Moderate shortness- joint pain	Marked shortness	**No shortness**	**No shortness**
Kendall	Pectoralis major- upper (clavicular) part	Slight shortness	Slight shortness	**No shortness**	**No shortness**
Kendall	Pectoralis minor	Slight shortness	Slight shortness	**No shortness**	**No shortness**
Kendall	Teres major, latissimus dorsi, romboid major and minor	Marked shortness- joint pain	Moderate shortness	**Slight shortness**	**No shortness**
Kendall	Lateral shoulder rotators	Slight shortness	No shortness	**No shortness**	No shortness
Kendall	Medial shoulder rotators	No shortness	No shortness	No shortness	No shortness
Janda	Cranial part of trapezius	Grade 2	Grade 2	**Grade 1**	**Grade 1**
Janda	Levator scapulae	Grade 2	Grade 1	**Grade 0**	**Grade 0**
Janda	SCM	Grade 1	Grade 2	**Grade 0**	**Grade 0**
Janda	Scalene	Grade 1	Grade 1	**Grade 0**	**Grade 0**

Table 22: Comparative table between initial kinesiological examination and changes during the therapy- Muscle length test

3.8.5 Anthropometric Measurements

During the initial Anthropometric Measurements, no pathologies or significant differences between the extremities were found.

3.8.6 Fascia examination

The following tables are in aim to compare the therapy progression in fascia treatment. The therapeutical improvements are written in bold font.

	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Deep lumbar fascia- caudally	x	x	x	x
Dorsal fascia- cranially	x	x	x	x
Lateral fascia of the trunk	x	x	x	x
Fascia around the thorax-laterally	Hard barrier	Hard barrier	**Slightly restricted barrier**	**Normal barrier**
Neck fascia	Hard barrier	Normal barrier	**Normal barrier**	Normal barrier
Pectoral fascia	Hard barrier in all directions	Hard barrier in all directions	**Normal barrier**	**Normal barrier**
Plantar fascia	Normal barrier	Normal barrier	Normal barrier	Normal barrier
Fascia of the thigh (anterior side)	Normal barrier	Slightly restricted barrier	Normal barrier	**Normal barrier**
Fascia of the thigh (posterior side)	x	x	x	x
Calf fascia	Normal barrier	Slightly restricted barrier	Normal barrier	**Normal barrier**

Table 23: Comparative table between initial kinesiological examination and changes during the therapy- Fascia examination

3.8.7 Examination of muscle tone

The following tables are in aim to compare the changes in muscle tone during the therapy. The therapy was mostly concentrated on the relaxation of hypertonic muscles by the STT and massages. The therapeutical improvements are written in bold font.

Upper extremities	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Levator scapule	x	x	x	x
Trapezius	Hypertonic in upper part	Hypertonic in upper part	**Slightly hypertonic in upper part**	**Slightly hypertonic in upper part**
Supraspinatus	x	x	x	x
Infraspinatus	x	x	x	x
Pectoralis major	Hypertonic	Hypertonic	**Slightly hypertonic**	**Slightly hypertonic**
Pectoralis minor	Hypertonic	Slightly hypertonic	**Slightly hypertonic**	**Normal muscle tone**
Latissimus dorsi	x	x	x	x
Anterior deltoid	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Middle deltoid	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Posterior deltoid	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Biceps brachii	Hypotonic	Normal muscle tone	Hypotonic	Normal muscle tone
Triceps brachii	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Brachioradialis	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone

Table 24: Comparative table between initial kinesiological examination and changes during the therapy- Examination of muscle tone. Upper extremity

Lower extremities	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Gluteus Maximus	x	x	x	x
Biceps femoris	x	x	x	x
Semitendinosus	x	x	x	x

Semimembranosus	x	x	x	x
Rectus femoris	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Vastus medialis	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Vastus lateralis	Hypotonic	Normal muscle tone	Hypotonic	Normal muscle tone
Tibialis anterior	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Gastrocnemius-medial	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Gastrocnemius-lateral	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Piriformis	x	x	x	x

Table 25: Comparative table between initial kinesiological examination and changes during the therapy. Examination of muscle tone. Lower extremity

Trunk and neck	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Rectus abdominis	Hypotonic	Hypotonic	Hypotonic	Hypotonic
External abdominal oblique	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Internal abdominal oblique	Hypotonic	Hypotonic	Hypotonic	Hypotonic
Errector spinae	x	x	x	x
Quadratus lumborum	Normal muscle tone	Normal muscle tone	Normal muscle tone	Normal muscle tone
Scalenius anterior	Hypertonic	Hypertonic	**Normal muscle tone**	**Normal muscle tone**
Scalenius medius	Hypertonic	Hypertonic	**Normal muscle tone**	**Normal muscle tone**
Scalenius posterior	Hypertonic	Hypertonic	**Normal muscle tone**	**Normal muscle tone**

SCM	Normal muscle tone	Hypertonic	Normal muscle tone	**Normal muscle tone**

Table 26: Comparative table between initial kinesiological examination and changes during the therapy. Examination of muscle tone. Trunk and neck

3.8.8 Joint play examination according to Lewit

The following tables are in aim to compare the therapy progression in ROM. The therapeutical improvements are written in bold font.

Lower extremities	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Metatarsophalangeal (MTP)	Dorsal direction- 1st restricted Ventral direction- 1st, 2nd restricted	Dorsal direction- 1st, 4th restricted Ventral direction- free joint play	**Dorsal direction- free joint play Ventral direction-free joint play**	**Dorsal direction- free joint play Ventral direction- free joint play**
Proximal interphalangeal	Dorsal direction- 2nd, 4th restricted Ventral direction- free joint play Laterolateral direction- free joint play	Dorsal direction- 2nd restricted Ventral direction- free joint play Laterolateral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play Laterolateral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play Laterolateral direction- free joint play
Distal phalanges	Free joint play	Free joint play	Free joint play	Free joint play
Lisfranc's (tarsometatarsal)	Restricted	Restricted	**Free joint play**	**Free joint play**
Chopart's (transverse tarsal)	Restricted	Restricted	**Free joint play**	**Free joint play**

Subtalar	Free joint play	Free joint play	Free joint play	Free joint play
Talocrural	Free joint play	Free joint play	Free joint play	Free joint play
Tibiofibular	Dorsal direction- restricted Ventral direction- free joint play	Dorsal direction- restricted Ventral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play
Patella	Craniocaudal direction- slight restriction Laterolateral direction- restricted	Craniocaudal direction- slight restriction Laterolateral direction- restricted	**Craniocaudal direction-free joint play Laterolateral direction- free joint play**	**Craniocaudal direction- free joint play Laterolateral direction- free joint play**

Table 27: Comparative table between initial kinesiological examination and changes during the therapy. Joint play examination. Lower extremity

Pelvis/SI joint	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Ilium against the sacrum- springing test in supine position	Restricted	Free joint play	**Free joint play**	Free joint play
Rosina test	x	x	x	x
Superior part of sacroiliac joint- springing test in prone position	x	x	x	x
The 'spine sign' test	x	x	x	x

Table 28: Comparative table between initial kinesiological examination and changes during the therapy. Joint play examination. Pelvis

Upper extremity and ribs	Initial KE		Changes during the therapy	
	Left	Right	Left	Right
Distal interphalangeal(DIP)	Dorsal direction- 4th, 3rd restricted Ventral direction- 2nd restricted	Dorsal direction- 2nd, 4th restricted Ventral direction- free joint play	**Dorsal direction- free joint play Ventral direction- free joint play**	**Dorsal direction- free joint play Ventral direction- free joint play**
Proximal interphalangeal(PIP)	Dorsal direction- 2nd, 3rd restricted Ventral direction- free joint play Laterolateral direction- free joint play	Dorsal direction- 2nd restricted Ventral direction- free joint play Laterolateral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play Laterolateral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play Laterolateral direction- free joint play
Interphalangeal (IP)- thumb	Dorsal direction- restricted Ventral direction- free joint play	Dorsal direction- restricted Ventral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play	**Dorsal direction- free joint play** Ventral direction- free joint play
Metacarpophalangeal (MCP)	Dorsal direction- 1st, 2nd,3rd restricted Ventral direction- 1st, 2nd restricted	Dorsal direction- 1st, 2nd,3rd restricted Ventral direction- 1st, 2nd,5th restricted	**Dorsal direction- free joint play Ventral direction- free joint play**	**Dorsal direction- free joint play Ventral direction- free joint play**
Carpometacarpal (CMC)	Free joint play	Free joint play	Free joint play	Free joint play

Individual carpal bones	Capitate/lunate-restricted	Free joint play	**Free joint play**	Free joint play
Radiocarpal	Free joint play	Free joint play	Free joint play	Free joint play
Proximal row of carpal bones	Restricted	Free joint play	**Free joint play**	Free joint play
Distal row of carpal bones	Free joint play	Free joint play	Free joint play	Free joint play
Elbow- radial direction	x	x	x	x
Elbow- ulnar direction	x	x	x	x
Shoulder joint	x	x	x	x
Acromioclavicular	Dorsal direction-restricted Ventral direction-restricted	Dorsal direction-restricted Ventral direction-free joint play	**Dorsal direction-free joint play Ventral direction-free joint play**	**Dorsal direction-free joint play** Ventral direction-free joint play
Sternoclavicular	Restricted	Restricted	**Free joint play**	**Free joint play**
Movement of the scapula against the trunk	x	x	x	x
Ribs (supine position)	Inhalation- 2nd, 3rd,4th restricted Exhalation-2nd,3rd restricted	Inhalation-3rd restricted Exhalation-2nd restricted	**Inhalation-2nd,3rd,4th slightly restricted Exhalation-free joint play**	**Inhalation-free joint play Exhalation-free joint play**
1st rib	x	x	x	x

Table 29: Comparative table between initial kinesiological examination and changes during the therapy. Joint play examination. Upper extremity

3.8.9 Evaluation of the therapy. Conclusion

After all therapeutic sessions, I was able to help the patient to solve the problems found during the initial kinesiological examination, but it didn't affect the global problem. Pneumonia in connection with COVID-19 left the consequences which are not possible to solve by physiotherapy, however, I did everything I could from my side.

As a result of pneumonia and post-Covid state the breathing stereotype was severely changed and became pathological. The breathing pattern slightly changed from day to day mostly depending on the level of the excessive secretion of the airways. In general, I could observe the improvements in breathing in the first 7-9 days working with the patient. At this point, I was able to help the patient with most of the problems found in the initial kinesiological examination that could lead to the worsening of the patient's condition and could be aggravating factors.

Respiratory physiotherapy helped to clean airways, prolong the inspiratory and expiratory periods and increase the saturation level. Mostly I saw the positive changes right after the therapy was applied. The pathological breathing pattern affected surrounding structures, these problems were possible to solve by physiotherapy and it was one of the main therapeutical goals.

The scalene, SCM, levator scapulae, lateral shoulder rotators, pectoralis major and minor were not shortened anymore after the therapies and the muscle length of the cranial part of trapezius significantly improved. I was working with cranial part of trapezius and pectoralis more time due to the high hypertonicity of these muscles. The combination of STT, massages, and gentle stretching worked perfectly to decrease muscle hypertone and increase muscle length. The same techniques were used for SCM, scalenus anterior, medius, and posterior.

The fascias around the thorax and neck, pectoral fascias had very hard barriers and were highly restricted by the pathological breathing pattern and other problems. When the surrounding muscles were stretched and relaxed, it helped to release the fascia barriers.

The joint play of the DIP, PIP, IP, MCP, CMC, individual carpal bones, a

proximal row of the carpal bones was mobilized within one session, however, some of the joint restrictions took more time to restore and it complicated the therapy. Since the patient was in an induced coma, she wasn't able to follow the therapeutical instructions for joint mobilization and make a deep breath or hold the breath. In addition to this, the left part of the chest often didn't demonstrate any movement in ventro-dorsal direction and it made the ribs mobilization in inhalation extremely difficult, so the therapy had to be applied more times than it usually takes.

During the initial KE the lower part of the body was also examined because prolonged lying position and other factors could lead to complications. It was the secondary goal, according to this, all found restrictions were solved after the main goals. It included stretching of shorted ankle plantar flexors and piriformis on the left extremity and both hamstrings, fascia releasing technique for the right LE on thigh and calf. Also joint play mobilization of MTP, PIP, Lisfranc, Chopart, tibiofibular joint, patella, and SI joint. All treatments were successful without any difficulties.

Also during the initial KE, no pathologies were found in neurological examination, so the treatments were not concentrated on any neurological problems.

The last therapy with the patient was performed on Thursday 4.2., due to the fact that on Friday 5.2. a tracheostomy was provided. In the last 1-2 days, I have noticed deterioration in the general condition of the patient. Most of all this was manifested in the change in breathing. On the last day of therapy, breathing wave was very superficial, movement in the left side of the chest in the ventro-dorsal direction was completely absent, while movement on the right side was significantly impaired.

Lateral movement of the lower part of the chest on the right side was only slightly noticeable, and on the left side, it was almost completely absent. Since in the first days of working with the patient, there was no lateral movement, but after the relaxation of muscles, fascias, and respiratory physiotherapy, there was a noticeable improvement, so I can associate the decrease in lateral movement with the general deterioration of the patient's condition.

Pathological vibration due to the movement of excessive secretions in the airways was noticeable only on the right side in inhalation and exhalation. On the left side, there was no vibration due to the fact that there was no movement in the left part of the chest, therefore the excretion remained motionless. The vibration on the right side manifested with slight accompanying sounds in the upper and middle thoracic regions on the right side.

In addition, the positioning that initially helped to breathe easily ceased to make any positive changes on the last day of the therapy.

Due to the fact that I didn't have the opportunity to follow the patient's condition for the last 2-3 days of her life, I cannot say if there were any other changes besides those described above.

To sum up everything I would like to say that the therapy was effective to solve some of the problems that the patient had, but the physiotherapy couldn't affect the general state of the patient due to severe lung damage.

4.Conclusion of the work

I chose this patient because her diagnosis and clinical picture were very interesting to me. Nowadays, the topic of covid is very much discussed all over the world and I wanted to get deeper into this topic. Besides, I have not previously worked with a patient with respiratory disease, so for me, it was a great opportunity to go beyond the usual boundaries.

During a month of work in the IKEM, I managed to get a great amount of new knowledge and experience. I am very grateful to Bc. Robert Charvat and Mgr. Daniela Sarazova for their support, time, and knowledge they shared with me.

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6.Supplements

6.1 Abbreviations

ABD	Abduction
ACBT	Active Cycle of Breathing Techniques
ACE2	Angiotensin-Converting Enzyme
ADD	Adduction
ADL	Activity of Daily Living
ARDS	Acute Respiratory Distress Syndrome
ARO	Department of Anaesthesiology and Resuscitation
AROM	Active Range of Motion
BMI	Body Mass Index
CAP	Community-acquired pneumonia
CMC	Carpometacarpal
COPD	Chronic Obstructive Pulmonary Disease
COVID-19	Coronavirus Disease
CI	Confidence interval
CVD	Cardiovascular Disease
DAD	Diffuse Alveolar Damage
DIP	Distal Interphalangeal
DSS	Deep Stabilization System
EXT	Extension
FLX	Flexion
HAP	Hospital-Acquired Pneumonia
HCAP	Healthcare-Associated Pneumonia
HFCWO	High Frequency Chest Wall Oscillation
HR	Heart Rate
ICU	Intensive Care Unit
IP	Interphalangeal

KE	Kinesiological Examination
LE	Lower Extremity
LRTI	Lower Respiratory Tract Infection
MCP	Metacarpophalangeal
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
MTP	Metatarsophalangeal
NG	Nasogastric
OR	Odds Ratio
PCR	Polymerase Chain Reaction
PIP	Proximal Interphalangeal
PIR	Post Isometric Relaxation
PNF	Proprioceptive Neuromuscular Facilitation
PPE	Personal Protective Equipment
PROM	Passive Range of Motion
PT	Physical Therapy
RHB	Rehabilitation
RNA	Ribonucleic Acid
ROM	Range of Motion
SARS	Severe Acute Respiratory Syndrome
SARS-CoV	Severe Acute Respiratory Syndrome Coronavirus
SARS-CoV-2	Severe Acute Respiratory Syndrome 2
SCM	Sternocleidomastoid
SI	Sacroiliac
SFTR	Sagittal-Frontal-Transverse-Rotation
ST	Soft Tissue
STT	Soft Tissue Technique
TE	Thromboembolic
UE	Upper Extremity
VAP	Ventilator-Associated Pneumonia
V/Q	Ventilation/Perfusion
X-Ray	X-Radiation

6.2 List of figures

6.3 List of tables

6.4 Ethics Committee Agreement

CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORT
José Martího 31, 162 52 Prague 6-VeIeslavín

Application for Approval by UK FTVS Ethics Committee

of a research project, thesis, dissertation or seminar work involving human subjects

The title of a project: Case study of a patient with pneumonia after Covid-19.

Project form: : Bachelor's Thesis

Period of realization of the project: January 2021- February 2021

Applicant: Ekaterina Trashchenko , UK FTVS, department of physiotherapy

Main researcher: Ekaterina Trashchenko , UK FTVS, department of physiotherapy

Workplace: Institut klinicke a experimentalni mediciny (IKEM)

Co-researcher(s): -

Supervisor: Mgr. Michaela Stupkova

Financial support: -

Project description: Case study of a patient with pneumonia, recoved after COVID-19 with implemention of physical tharapy procedures and evaluation of the results for the applied physiotherapy rehabilitation plan which is based on detailed kinesiological examination. Consisting also theoretical part from relevant literaure which will demonatrate explanation regarding the lung anatomy and function, pneumonia, COVID-19 and its complications
Characteristics of participants in the research: One female participant aged 75 diagnosed with pneumonia, after COVID-19.
Ensuring safety within the research: This research is taking place in IKEM in Prague, it will follow the precautions and risk prevention according to the hospital rules, policies and signed documents. Non invasive methods are used and all applied therapies, discussions and instructions are done under the supervision of Bc. Robert Charvat. Risks of therapy and methods will not be higher than the commonly anticipated risks for this type of therapy.
Ethical aspects of the research: The collected data will be anonymized within one week after the end of working with the patient. I understand that anonymization means that the text does not use any item of information or combination of items that could lead to the identification of a person. I will be careful not to enable recognition of a person in the text of the thesis, especially within the anamnesis. After the text has been anonymized, any personal data still kept elsewhere will be deleted. Photographs of the participant will be anonymized within one week after being taken by blurring the face, parts of the body or any characteristics that could lead to identification of the person. After anonymization any non-anonymized photographs will be deleted. All collected data will be safely stored on a PC safeguarded by a keyword in a locked room, any data in paper form will be kept safely under lock and key in a locked room. The data will be processed, safely retained and published in an anonymous way in the bachelor thesis.
I shall ensure to the maximum extent possible that the research data will not be misused.
Informed Consent: attached

It is the duty of **all participants of the research team** to protect life, health, dignity, integrity, the right to self-determination, privacy and protection of the personal data of all research subjects, and to undertake all possible precautions. Responsibility for the protection of all research subjects lies on the researcher(s) and not on the research subjects themselves, even if they gave their consent to participation in the research. All participants of the research team must take into consideration ethical, legal and regulative norms and standards of research involving human subjects applicable not only in the Czech Republic but also internationally.
I confirm that this project description corresponds to the plan of the project and, in case of any change, especially of the methods used in the project, I will inform the UK FTVS Ethics Committee, which may require a re-submission of the application form.
In Prague, 25/01/2021 Applicant's signature:

Approval of UK FTVS Ethics Committee

The Committee: Chair: doc. PhDr. Irena Parry Martínková, Ph.D.
Members: prof. PhDr. Pavel Slepička, DrSc.
prof. MUDr. Jan Heller, CSc.
PhDr. Pavel Hrásky, Ph.D.
Mgr. Eva Prokešová, Ph.D.
Mgr. Tomáš Ruda, Ph.D.
MUDr. Simona Majorová

The research project was approved by UK FTVS Ethics Committee under the registration number: 075/2021
Date of approval: 26. 1. 2021

UK FTVS Ethics Committee reviewed the submitted research project and **found no contradictions** with valid principles, regulations and international guidelines for carrying out research involving human subjects.

The applicant has met the necessary requirements for receiving approval of UK FTVS Ethics Committee.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
20

Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee

6.5 Informed consent

INFORMOVANÝ SOUHLAS

Vážená paní, vážený pane,

v souladu se Všeobecnou deklarací lidských práv, nařízením Evropské Unie č. 2016/679 a zákonem č. 110/2019 Sb. – o zpracování osobních údajů, Helsinskou deklarací, přijatou 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013) a dalšími obecně závaznými právními předpisy Vás žádám o souhlas s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie prováděné v rámci praxe na ……., kde Vás příslušně kvalifikovaná osoba seznámila s Vaším vyšetřením a následnou terapií. Výsledky Vašeho vyšetření a průběh Vaší terapie bude publikován v rámci bakalářské práce na UK FTVS, s názvem ……

Cílem této bakalářské práce je …….....

Získané údaje, fotodokumentace, průběh a výsledky terapie budou uveřejněny v bakalářské práci v anonymizované podobě. Osobní data nebudou uvedena a budou uchována v anonymní podobě. V maximální možné míře zabezpečím, aby získaná data nebyla zneužita.

Jméno a příjmení řešitele ..... Podpis:.....

Jméno a příjmení osoby, která provedla poučení..... Podpis:.....

Prohlašuji a svým níže uvedeným vlastnoručním podpisem potvrzuji, že dobrovolně souhlasím s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie ve výše uvedené bakalářské práci, a že mi osoba, která provedla poučení, osobně vše podrobně vysvětlila, a že jsem měl(a) možnost si řádně a v dostatečném čase zvážit všechny relevantní informace, zeptat se na vše podstatné a že jsem dostal(a) jasné a srozumitelné odpovědi na své dotazy. Byl(a) jsem poučen(a) o právu odmítnout prezentování a uveřejnění výsledků vyšetření a průběhu terapie v bakalářské práci nebo svůj souhlas kdykoli odvolat bez represí, a to písemně zasláním Etické komisi UK FTVS, která bude následně informovat řešitele.

Místo, datum .....

Jméno a příjmení pacienta ..... Podpis pacienta: .....

Jméno a příjmení zákonného zástupce .....…..

Vztah zákonného zástupce k pacientovi ..... Podpis: .....

6.6 Image attachment