Functional Task Analysis

Phases to Follow

Study Manual

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Introduction

This study manual provides ESP students with educational tools that will enable them to gain theoretical knowledge and develop practical skills and competences in Functional Task Analysis. The students will be able to utilize the theoretical and practical skills derived from this study manual into practical application during clinical sessions, internships and future independent practice. The information in the study manual will be applicable in many different physiotherapeutic settings.

In order to devise the appropriate short-and long-term goals and choose interventions that will be applied in a treatment plan the physiotherapist must possess adequate assessment competences including Functional Task Analysis.

Physiotherapy students who gain knowledge and skills in the above mentioned topic will provide better quality care to the patients. Consequently better overall physiotherapy health services and treatment outcomes will result in higher credibility of the physiotherapy profession in the eyes of the public and other health care providers.

Furthermore, the physiotherapeutic diagnostic process will become transparent to insurance companies which in the long run will lead to better communication and reduced bureaucracy between the physiotherapy disciplines and the insurance companies. In addition, the overall financial costs of all parties will be reduced.

The study manual consists of two sections. Section one focuses on theoretical foundations of Functional Task Analysis whereas section two emphasizes its practical application.

The literature used throughout the study manual was collected from various books written by different health disciplines. Each of these disciplines emphasises the characteristics important for their profession. In addition, there is a lack of current physiotherapeutic literature in Functional Task Analysis. Therefore, some ideas in this study manual were developed by the authors in order to introduce a complete physiotherapeutic approach to this topic.
Section One: Theoretical Foundations of Functional Task Analysis

When looking at the overall physiotherapeutic sequential approach (see Figure 1), Functional Task Analysis is localized in the assessment aspect. Because assessment takes place in the therapist's mind, the process of clinical reasoning and analysis often seem inaccessible and complicated to the student. Experienced therapists think quickly, with little evident or conscious effort. Thinking patterns and diagnostic decision making during assessment are complex and sequential, therefore it is necessary for learning purposes to simplify the overall process by using the reductionism philosophy. This philosophy suggests that systematic breakdown of complex phenomena into their simpler component parts is a sound basis for understanding the complex system (Jamison, 2006).
Figure 1. Physiotherapeutic Sequential Approach (Giesen, 2005)
Definition of Task

While taking patient history the therapist finds, among others, limitations of activities and restrictions of participation. An activity is the execution of a task or the action by an individual (International Classification of Functioning, Disability and Health, 2007). Therefore, a task is either an element of an activity (e.g. sit to stand while transferring from the wheelchair to the toilet) or the activity itself (e.g. climbing stairs). The performance of a task contributes to the level of activities and participation.

A task can be influenced by three factors: Physical impairments, environmental factors and personal factors (see Figure 2). As causative components they either have a direct or an indirect influence on the performance of a task.

Figure 2. Influencing Factors on a Task (© Copyright, 2008)

Physical Impairments

Physical impairments include problems in body structures and body functions (International Classification of Functioning, Disability and Health, 2007). As causative components they contribute to functional loss and influence the accomplishment as well as the quality of a task. These components are numerous and present in diverse patterns among different individuals.

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1 Throughout the text a patient/client is referred to as an individual
2 Remark: Various definitions of a task exist. In this study manual, a task is defined taking the ICF language into consideration.
Environmental Factors

Environmental factors make up the physical, social and attitudinal environment (*International Classification of Functioning, Disability and Health, 2007*). Features of the environment in some instances enable or support performance or alternatively disable or hinder performance (Shumway-Cook & Woollacott, 2001).

The therapist must evaluate the environmental contexts in which the individual performs the task. Information about the environment may help determine whether it can be altered to allow the accomplishment of a task during treatment (Sandler Goldstein, 1995).

An example of the physical environment is the height of a chair which might influence the performance of a task. The attitude of others (family or friends) towards the individual is an example of the social and attitudinal environment. If the family is around when the individual is performing the task, he may be more/less motivated and perform the task better/worse.

Personal Factors

The therapist should pay attention to personal factors as they have an impact on the functioning of the individual. Perceiving and coping with a disease as well as the cultural background are examples of personal factors that may have influence on the performance of a task (*International Classification of Functioning, Disability and Health, 2007*).

Phases in Functional Task Analysis

As the starting therapist gains experience, he will develop thinking processes and analysis skills. It is the intention of the authors to help guide the starting therapist's thinking as he analyzes the information and findings while assessing. It has been stated by various literature (Bickley & Szilagyi, 2007; Gulmans, 1994; Jamison, 2006; Mattingly & Hayes Fleming, 1994; O'Sullivan & Schmitz, 2000; Prentice & Voight, 2001) that it is important to follow a sequence in order to progress from the individual’s presenting complaint to a diagnosis. Therefore, the authors break down the analysis of a task into phases. Listed below are four sequential phases that underlie the process of Functional Task Analysis (see Figure 3).

Functional Task Analysis is a complex process which requires knowledge of anatomy, assessment, kinesiology and physiology (Prentice & Voight, 2001). This specific knowledge is out of the scope of this study manual. Nevertheless, the reader should be aware that a therapist must possess this knowledge in order to be able to analyze a task.

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3 Throughout the text, both, male and female adults are referred as a ‘he’
Phase 1  Detection of Task Dysfunction(s)

The therapist will use the information obtained from patient history and make the relation between what he will expect to see and what will actually be observed and detected.

Movement Dysfunction(s)

In 1998, the term “movement dysfunction” was introduced in relationship to diagnosis by the physiotherapist (Prentice & Voight, 2001). Interpreting the terminology of the ICF model, movement dysfunction(s) are the manifestation of the physical impairments. For example, dragging of the foot during gait can be a manifestation of decreased strength of the dorsiflexors. In order to detect the movement dysfunction(s), the therapist starts with an observation of the individual while performing a task. If necessary the therapist will assist the individual physically and/or verbally. In addition, while assisting, the therapist receives sensory feedback about the individual's ability to accomplish the task. A list of criteria required for the detection of movement dysfunction(s) is given in Appendix 1 in order to provide a systematic approach.

Personal and Environmental Factors

When the performance of the task is disturbed, the therapist should detect relevant personal and environmental factors (see Figure 2).
Phase 2  Determination of Possible Causative Components

In this phase the therapist will determine the possible causative components that may explain the task dysfunction(s) observed in phase one. The causative components include physical impairments as well as environmental and personal factors. In order to determine the causative components, the therapist has to know all the factors which are involved in the performance of a task under "normal" circumstances (Appendix 2).

Phase 3  Elimination of Irrelevant Causative Components

After phase two is completed, the therapist will ascertain the actual causative components of the task dysfunction. In order to eliminate irrelevant causative components, the therapist needs to incorporate his experience, knowledge and skills about different tests and measuring instruments. These help to verify the individual’s ability to perform a task and its quality. While choosing the most appropriate test/measurement the therapist should take its evidence as well as the particular individual and situation into consideration (Turner et al. 1996).

Phase 4  Conclusion

This is the final phase in which the therapist develops a clinical picture that explains the disturbance of the task execution. Afterwards, the therapist will prioritize the causes according to severity and contribution to the movement dysfunction(s).

In the coming stages of the physiotherapeutic sequential approach (see Figure 1) the therapist will choose appropriate treatment interventions that are implemented in a treatment strategy which corresponds to the goal setting.
Task Analysis Form

The Task Analysis Form (TAF) is an implementation of the four sequential phases. In order to develop an analysis thinking process, a starting therapist is advised to use the TAF (see Figure 4 for an explanation). As the therapist advances, analysis thinking processes will become automatic and the use of the form will be optional.

<table>
<thead>
<tr>
<th>Name:</th>
<th>Condition:</th>
<th>Task:</th>
</tr>
</thead>
</table>

**Movement Dysfunction(s)**

This box describes the movement dysfunction(s) observed in phase one.

**Environmental Factors**

This box describes factors of the physical, social and attitudinal environment which is extracted from medical records, patient history, observation in phase one and interaction with the individual. It is determined as possible causative component in phase two.

**Personal Factors**

See environmental factors

**Physical Impairments**

This box describes physical impairments as possible causative components determined in phase two.

In phase three the therapist checkmarks the left box for the confirmed causative components and crosses out the eliminated ones after testing.

**Tests**

This box represents the chosen tests that are used to eliminate the irrelevant physical impairments.

Results of the tests should not be presented in this form as the form is meant to develop thinking processes and not data recording.

**Examples:**

- **✓ Muscle Strength** Manual Muscle Testing
- **✓ Coordination** Finger-to-nose test
- **✓ Balance** Berg Balance Scale

Muscle strength and balance tests are positive, therefore they are confirmed as causative components and check marked. Coordination test is negative thus it is crossed out and eliminated.

**Conclusion**

This box describes a clinical picture that explains the disturbance of the task execution (phase four).

**Figure 4.** Task Analysis Form (© Copyright, 2008)
Section Two: Practical Application of Functional Task Analysis

In this section, a neurological and an orthopaedic case are analyzed. The analysis of two different categories demonstrates the applicability of the four sequential phases mentioned in section one. In addition, the reader will gain a better understanding of how to apply the phases. Background information, videos, pictures and two completed task analysis forms are given, which will make the application of the four phases more transparent.

Two tasks are analyzed below: sit to stand and climbing stairs. The factors required for the performance of a task under “normal” circumstances (Appendix 2) as well as the description of the correct movement patterns of the two tasks (Appendix 3 and 4) are given to provide a transparent and complete practical application.

Case 1: Sit to Stand

Background Information

The background information contains relevant information obtained during patient history, which can be specifically related to the task.

Name: F.R.
Age: 51 years old (1956)
Gender: Male
Medical diagnosis: Diagnosed with Multiple Sclerosis (MS) in 1996

Other:
• Lives alone and is completely independent
• Has a girlfriend but no immediate family
• Can stand up independently
• Cannot control emotions → suddenly starts laughing or crying
• Sometimes feels very tired
• Has concentration problems
• Uses the wheelchair most of the time
• Goes to concerts on his own (with his scoot mobile)
• Works in the zoo in Amsterdam once a week
• At work he uses crutches and climbs three flights of stairs to get to his office
• Health Seeking Care Question: To maintain the level of independence
Videos

Different views of the individual executing the task are available in videos and pictures. It is recommended to watch the videos once before reading the completed task analysis form. While watching the therapist should try to detect any movement dysfunctions. Afterwards, proceed to the completed task analysis form. If necessary the videos can be watched again. 4

Video 1
Frontal View of the Entire Body

Video 2
Saggital View of the Entire Body

Video 3
Frontal View Close Up Lower Body

Video 4
Saggital View Close Up Lower Body

Video 5
Frontal View Close Up Upper Body

4 Remark: The videos do not include sound. Although it is mentioned in section one that verbal instructions are given if necessary, they are not included because the emphasis is placed on the detection of dysfunction(s).
Name: F.R.  
Condition: Multiple Sclerosis  
Task: Sit to Stand

### Movement Dysfunction(s)

**Base of Support:**
- Wide base of support (stance phase) **Picture 1**
- The right foot is in front of the left foot (stance phase)
- Favours the left leg in weight bearing (stance phase)
- Sometimes holds the armrest with the right hand (extension phase) **Picture 2**

**Alignment (end of extension phase):**
- Standing with obvious flexed hips

**Sequence of Movement:**
- Initiation of movement is delayed (beginning of transfer phase)
- Slowness and clumsiness of movement (entire stance phase)
- Uses hands to move the right leg backwards (seated phase)
- Uses upper limbs to push up from the chair (transfer phase)
- While he favours the left leg the upper body shifts to the left (extension phase)
- The upper body shifts back laterally toward the centre (end of extension phase)

**Others:**
- Leans against the wheelchair with the back of his legs after several repetitions of the task (extension phase) **Picture 3**

### Environmental Factors

<table>
<thead>
<tr>
<th>Physical: While the armrests of the wheelchair offer support in the transfer phase, the wheelchair also creates an unsafe environment because it tilts back and forth in the extension phase.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Personal Factors:</strong> He has a positive attitude, tries to get the most out of life in the constraints of his condition.</td>
</tr>
</tbody>
</table>

### Physical Impairments

<table>
<thead>
<tr>
<th>Physical Impairments</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Strength</td>
<td>Manual Muscle Testing</td>
</tr>
<tr>
<td>✓ Muscle Endurance</td>
<td>Repetitive Manual Muscle Testing</td>
</tr>
<tr>
<td>✓ Coordination</td>
<td>Finger-to-nose &amp; Heel-to-shin</td>
</tr>
<tr>
<td>✓ Balance</td>
<td>Berg Balance Scale</td>
</tr>
<tr>
<td>✓ Fatigue</td>
<td>Modified Fatigue Impact Scale</td>
</tr>
<tr>
<td>✓ Sensation</td>
<td>Superficial Sensation &amp; Proprioception Test</td>
</tr>
<tr>
<td>✅ Vision</td>
<td>According to medical records</td>
</tr>
<tr>
<td>✓ Muscle Tone</td>
<td>Modified Ashworth Scale</td>
</tr>
<tr>
<td>✅ Emotional function</td>
<td>According to diagnosis and observation</td>
</tr>
<tr>
<td>✓ Concentration</td>
<td>According to diagnosis</td>
</tr>
</tbody>
</table>

### Conclusion

The patient has difficulties to stand up from the wheelchair due to the following:
- Wide base of support and use of armrest: ↓ balance and strength
- ↑ weight bearing on left leg: ↓ strength in right leg
- Use of upper limbs to push up from the chair: ↓ strength in the legs
- Slowness and clumsiness of movement: problems in sensation (↓ superficial sensation and proprioception) and coordination
- Cannot perform sit to stand repetitively: ↓ muscle endurance and ↑ fatigue

Remarks: The ability to stand is influenced positively by spasticity in the right leg and by his positive attitude.

**Figure 5.** Task Analysis Form Case 1
Case 2: Climbing stairs

For learning purposes, the starting therapist is asked to analyze the second task himself. A blank TAF form (Appendix 5) and the answer key (Appendix 6) can be found at the end of the study manual.

Background Information

Name: D.V.D.N.
Age: 76 years old (1931)
Gender: Female
Medical Diagnosis: Osteoarthritis right knee joint
Referral: Total Knee Replacement right two weeks ago
Medication: Blood thinners (TIA seven months ago), medication for hypertension

Other:
- Climbed stairs for first time after surgery
- She feels weaker in her right leg
- Difficulties with flexing her operated knee
- Swelling and pain (VAS 6)
- Has also osteoarthritis in left knee joint which causes pain and will replace it in a year time
- Lives in an apartment and needs to climb two steps
- Lives with her family which support her
- Health Seeking Care Question: To be able to climb stairs in order to visit friends

Videos

Video 1
Frontal View

Video 2
Saggital View

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Remark: No close up videos are given for this case because of limited amount of time for the shooting.
References


Appendix 1: Criteria Required for the Detection of Movement Dysfunction(s)

The detection of movement dysfunction(s) may be difficult for the therapist. Therefore, the use of certain criteria is recommended. This criteria list was created according to Sandler Goldstein (1995). Some modifications were added by the authors of the study manual. The therapist should be aware that he needs to choose which of the below given aspects are relevant for the specific task.

**Base of Support**

- Width of base (e.g. wide or narrow)
- Weight bearing
- Others

**Sequence of Movement**

- Order of occurrence
- Initiation of movement (e.g. delayed)
- Speed (e.g. fast or slow)
- Others

**Alignment**

- Position of joints (incl. ROM)
- Asymmetry
- Others

**Outcome**

- Completion of movement (e.g. partially completed)
- Others

**General Appearance** (e.g. sweating, facial expression)

**Others**

**References**

Appendix 2: Factors Required for the Performance of a Task

Below one can find a list of functioning and contextual factors which should help to guide the starting therapist. This list was developed on the basis of the ICF. However, a few important items were missing and thus were added.

Part I. Functioning Factors

Functioning factors are those factors that reside within the individual and that may affect the performance of a task. They include, among others, body functions (i.e. the physiological aspect) and body structures (i.e. the anatomical aspect) of human performance (Hersch et al. 2005). If a body function or structure is impaired it will be classified as physical impairment (International Classification of Functioning, Disability and Health, 2007).

Body Functions

- Mental Functions
  - Consciousness
  - Orientation (time, place, person)
  - Intellectual
  - Energy and drive functions
  - Sleep
  - Concentration
  - Memory
  - Emotional functions
  - Perceptual functions
  - Higher level cognitive functions
  - Language

- Sensory Functions and Pain
  - Vision
  - Hearing
  - Vestibular (incl. balance functions: Static and dynamic)
  - Sensation: Superficial sensation and proprioception (Watson, 1997)
  - Pain

- Voice and Speech Functions

- Functions of the Cardiovascular, Haematological, Immunological and Respiratory Systems
  - Heart
  - Blood pressure
  - Endurance (Hersch et al. 2005)
  - Differentiation between energy systems (CP, anaerobic and aerobic) (Widmaier et al. 2006)
- Functions of the Digestive, Metabolic and Endocrine Systems
  - Digestive
  - Defecation
  - Weight maintenance
  - Endocrine glands (hormonal changes)

Genitourinary and Reproductive Functions
  - Urination functions
  - Sexual functions

- Neuromusculoskeletal and Movement Related Functions
  - Mobility of joints
  - Stability of bones
  - Strength
  - Muscle endurance
  - Muscle tone
  - Involuntary movements (Hersch et al. 2005)
  - Motor functions (incl. coordination, etc.) (Watson, 1997)

- Functions of the Skin and Related Structures

- Any Other Body Functions

Body Structures
- Structure of the Nervous System
  - Brain
  - Spinal cord and peripheral nerves

- The Eye, Ear and Related Structures

- Structures Involved in Voice and Speech

- Structure of the Cardiovascular, Immunological and Respiratory System

- Structures Related to the Digestive, Metabolism and Endocrine Systems

- Structure Related to Genitourinary and Reproductive System

- Structure Related to Movement
  - Head and neck region
o Shoulder region
o Upper extremity (arm, hand)
o Pelvis
o Lower extremity (leg, foot)
o Trunk

- Skin and Related Structures
- Any Other Body Structures

Part III. Contextual Factors

Contextual factors are those factors that are concerned with the whole person in a social context. Among contextual factors are external environmental factors (i.e. the physical, social and attitudinal environment in which people live and conduct their lives) and internal personal factors (e.g. lifestyle, habits, social background, education life events, race/ethnicity, sexual orientation and assets of the individual) (International Classification of Functioning, Disability and Health, 2007).

Environmental Factors

- Products and Technology
  o For personal consumption (food, medicines)
  o For personal use in daily living
  o For personal indoor and outdoor mobility and transportation
  o Products for communication
  o Design, construction and building products and technology of buildings for public use
  o Design, construction and building products and technology of buildings for private use

- Natural Environment and Human Made Changes to Environment
  o Climate
  o Light
  o Sound

- Support and Relationships
  o Immediate family
  o Friends
  o Acquaintances, peers, colleagues, neighbours and community members
  o People in position of authority
  o Personal care providers and personal assistance
  o Health professionals
  o Health related professionals

- Attitudes
  o Individual attitudes of immediate family members
Individual attitudes of friends
Individual attitudes of personal care providers and personal assistance
Individual attitudes of health professionals
Individual attitudes of health related professionals
Societal attitudes
Social norms, practices and ideologies

• Services, Systems and Policies
  o Housing services, systems and policies
  o Communication services, systems and policies
  o Transportation services, systems and policies
  o Legal services, systems and policies
  o Social security services, systems and policies
  o General social support services, systems and policies
  o Health services, systems and policies
  o Education and training services, systems and policies
  o Labour and employment services, systems and policies

• Any Other Environmental Factors

Personal Factors

The personal factors are not classified in ICF because of the large social and cultural variance associated with them (International Classification of Functioning, Disability and Health, 2007). However, below one can find some general examples that should give the starting therapist some ideas of what is meant by personal factors.

• Lifestyle
• Habits
• Social Background
• Education
• Life Events
• Race/Ethnicity
• Sexual Orientation
• Assets of the Individual
• Any Other Personal Factors
References


Appendix 3: Correct Movement Pattern of Sit to Stand from a Chair

The ability to rise from sitting to standing is essential for the achievement of many everyday activities. There are patterns of joint movement and muscle activity during rising from a chair that are normally stored as motor programs in the motor cortex of the brain. For the majority of the population, getting out of a chair is an automatic activity requiring no thought. It is only when the chair is particularly low or deep or the individual is feeling tired or weak that the activity requires conscious thought in order to complete the action (Trew & Everett, 2005).

Description of movement in phases

There are different methods of identifying the different phases from sitting to standing. Here the method described by Trew and Everett (2005) is used. According to them, there are two main phases from sit to stand: the seated phase and the stance phase.

The period of time needed to complete the seated and stance phase varies but takes on average 1-3 seconds. The seated phase consists of about 30% of the total movement time and in the stance phase the transfer and extension components take 20% and 50% respectively (Trew & Everett, 2005).

Seated phase

The subject prepares for standing by adjusting the position of the limbs and trunk to cause the centre of gravity to move forward until it is almost over the feet. Usually, the feet start from a position parallel to one another or one foot is slightly in front of the other depending on different circumstances (Trew & Everett, 2005).

As the person stands, the feet become the base of support and for balance to be achieved; the centre of gravity must be moved horizontally until it is directly above them. This begins by bringing the feet backward to a position behind an imaginary perpendicular line drawn from the knees. This movement allows the lower limb extensor muscles to generate a force that essential to propel the body mass forward in the stance phase (Carr & Shepherd, 1998). It also helps to conserve energy because the horizontal distance that the centre of gravity has to travel is minimized. Conversely, if the feet are placed too far back, the knee extensors will be in a lengthened position and may not be at their optimum length to generate force (Trew & Everett, 2005).

The trunk and head are then simultaneously moved forward which is done by hip flexion to about 120 degree. The hip flexors initiate the movement and the anterior abdominal muscles contract isometrically to ensure that the trunk follows the hip movement. Towards the end of the hip flexion phase there may be slight eccentric activity of the hip extensors to control the forward movement (Trew & Everett, 2005).
There is only slight trunk flexion in this phase. Within the spine the greatest ranges of movement occur in the cervical region in order to carry the head forwards and to keep the eyes horizontal.

If the upper limbs are not being used to push up from the chair arms, there is usually a slight flexion in the shoulder joints.

The forward movement of the trunk and upper limbs serve to move the centre of gravity forwards and also provide horizontal momentum.

The seated phase ends with the lift-off from the chair (Trew & Everett, 2005).

**Stance phase**

The subject’s weight is taken through the lower limbs as the centre of gravity is transferred forwards and upwards. There are two sub phases in the stance phase (Trew & Everett, 2005):

- **Transfer phase**: The centre of gravity is transferred forwards until it is slightly in front of the ankle joint. There is peak quadriceps and hip extensor activity at the instant of lift-off when the knees and hips extend to raise the body off the seat. Dorsiflexion of the ankle joints reaches its maximum during this phase. The trunk and arm continues the horizontal movement until it is in front of the ankle joints. The cervical spine extends to keep the eyes looking straight ahead. It is also a time of instability because the body is no longer supported by the seat.

- **Extension phase**: The vertical movement takes place. The lower limbs extend until the erect posture is achieved. Extension of the hips and knees begins and there is also slight plantar flexion of the ankle joints. The trunk also starts to extend and the cervical spine flexes to keep the vertex of the skull uppermost. The upper limbs relax and return to their normal resting position. At the end, the cervical spine flexes and extends to adjust the head position.

**Involvement of upper limbs**

Whether the upper limbs are involved in the process of getting out of a chair depends on the strength of the individual, the height of the chair and the presence of armrests. Under normal circumstances the upper limbs are not essential to the activity and can be used for carrying or manipulating objects. However, if weakness, balance problems or pain are factors then the upper limbs will be used to assist. It is estimated that the force production by the hip and knee extensor muscles can be reduced by about 50% if armrests are used (Trew & Everett, 2005).
Speed

There is an optimum speed for rising from a chair. Too fast is likely to induce loss of balance and require excessive muscle force to prevent an unwanted step or fall. If the speed is too slow the momentum needed to assist the transfer of weight from the seat to the lower limbs will not be achieved and either the activity will fail or excessive amounts of energy will be required for successful completion.

The height of the chair relative to the subject’s leg length, the age of the subject and the degree of joint mobility as well as the muscle strength all have effects on the velocity of movement.

Individuals with movement dysfunction or neural dysfunction have been found to stand up relatively more slowly (Trew & Everett, 2005).

Balance

Balance is crucial for going from sitting to standing because the centre of gravity is moving in relation to the base of support (Trew & Everett, 2005).

Joint Range

It is suggested by Trew and Everett (2005) that subjects require more than 100 degrees of flexion in the hip and knee joints as well as full range of dorsiflexion to complete a successful sit to stand motion.

Flexibility of the cervical spine is also important because balance requires correct head positioning and if the vertebral column is stiff, then the appropriate positions may not be achieved (Trew & Everett, 2005).

Muscle Activity

Monoarticular and biarticular muscles across the hip, knee and ankle joints are used during this motion. In addition, trunk muscles are active to stabilize the upper body (Carr & Shepard, 1998).

Trunk muscles:

- Erector spinae
- Rectus abdominus

Lower limb muscles:

- Tibialis Anterior (placing the foot backward, stabilize the shin on the foot early in the action and to forward movement of the shin on the foot)
• Hip extensors (gluteus maximus & biceps femoris) and knee extensors (rectus femoris, vastus lateralis, vastus medialis) work almost simultaneously. Hip and knee extensor muscles demonstrate peak activity around the time the thighs are lifted off the seat.

• Iliopsoas is an expectorating muscle to initiate trunk flexion (however it is difficult to detect by EMG, since it is a deep muscle)

• Rectus femoris contributes to hip flexion while biceps femoris exerts a braking force at the hip, thus serving to slow down hip flexion at the hip prior to the beginning of lower limb extension.

References


Appendix 4: Correct Movement Pattern of Climbing Stairs

Step to pattern is when the foot is placed on the same step in which the other foot is.

Step over pattern is when the foot is placed in the next stair over the other foot.

Ascending Stairs

It starts when the joints of the leg flex to place the foot on the step above (Trew & Everett, 2005).

Stance Phase

The first contact of the foot on the step (weight acceptance) starts from the anterior and middle third of the foot and then the weight is transferred to the entire foot. During this moment, there is strong contraction of the hip and knee extensors to extend the lower limb and raise the body up to and over the step. The vertical forces through the tibia and also the compression force between the patella and the femur are estimated to be around three times of body weight. The plantar flexors are active in moving the tibia posterior on the talus (Trew & Everett, 2005).

The single-leg support starts with the contraction of the hip abductors to prevent the pelvis dropping to the unsupported side.

After all the body weight is transmitted on the stance leg, the knee is extended. The knee extensors work isometrically to maintain joint position while the centre of gravity is moving in front of the stance foot.

The stance phase ends by strong contraction of the calf muscles in order to accelerate the body forwards and upwards onto the new weight bearing leg (Trew & Everett, 2005).

Swing Phase

There is flexion in all the lower limb joints during this phase in order to allow the swing leg to step over to the next step. This is done by the contraction of the hip and knee flexors as well as the dorsi flexors.

During the mid swing, the quadriceps may contract eccentrically to prevent excessive knee flexion.

In the later swing phase, the hamstrings contract again to increase knee flexion so that the foot clears the top step. To gain step contact of the swing leg on the next step, the foot has to be lowered onto the step by slight hip extension controlled by eccentric contraction of the hip flexors.
Throughout the swing phase, the dorsiflexors contract isometrically to hold the ankle joint in dorsiflexion to avoid dragging of the toes. Immediately before foot contact, the dorsiflexors contract eccentrically to lower the forefoot onto the step (Trew & Everett, 2005).

**Descending Stairs**

It starts with the extended hip and knee positioning the foot on the step below (Trew & Everett, 2005).

**Stance Phase**

The foot contact (weight acceptance) begins with the anterior and lateral border of the foot. The plantar flexors of the ankle joint contract eccentrically to move from the initial plantarflexion position into a neutral or dorsiflexion position.

The hip joints are in very slight flexion and the knee joint may flex up to 50 degrees. This is controlled by eccentric contraction of the hip and knee extensors.

The knee extensors then contract concentrically to extend the knee about 10 degrees whilst the trunk moves horizontally to carry the centre of gravity over the stance leg. Ankle dorsiflexors contract with the calf muscles to control ankle position and to maintain weight bearing on the lateral border of the foot.

In order to lower the body weight, the hip and knee flex and the ankle dorsiflexes. This involves the eccentric contraction of the knee extensors, calf muscles and hip extensors. The stance ankle is in maximum dorsiflexion with the body weight tending to propel the movement further. To prevent excessive dorsiflexion at the ankle joint, the plantar flexors may need to contract.

Throughout this phase, the hip abductors contract on the stance leg in order to maintain the level of the pelvis (Trew & Everett, 2005).

**Swing Phase**

In this phase, the lower limb raises off the step and swings forwards and downwards. The hip and knee flexors work concentrically to raise the foot off the top step and pull the limb forwards. Then the limb starts to extend and prepares for foot placement by the eccentric contraction of the hip and knee flexors to decelerate the extension of the hip and knee joint.

The ankle joint drops into plantarflexion, controlled by eccentric work of the anterior tibial muscles which also maintain the foot in inversion in preparation for weight to be taken on the lateral border of the foot. The hip ipsilateral abductors contract just before the end of the swing phase in preparation for maintaining pelvic levels (Trew & Everett, 2005).
Joint Range

The amount of joint range needed for ascending and descending stairs depends on the depth of the step. For a standardized step, the hip joint must be able to move between full extension and about 60 degrees flexion. The range of motion required in the knee joint is from 0 to 100 degrees. The ankle joint needs full dorsiflexion. Active plantarflexion of the ankle is not required but is an option depending on the individual’s mood and the speed of the movement (Davies, 2000).

Muscle Activity

Muscle activity is predominantly concentric in ascending stairs while the muscle activity is eccentric in descending stairs.

The peak muscle activity occurs at the beginning of the swing phase during ascending of stairs. The hip and knee joints of the stance leg are in considerable flexion and substantial effort is needed from the extensors muscles to raise the body (Trew & Everett, 2005).

Balance

In stair climbing, the single-stance phase requires optimal balance ability, because the base of support is at its smallest (Trew & Everett, 2005).

References

- Davies, P.M. (2000). Steps to Follow. 2nd ed. Heidelberg: Springer-Verlag GmbH.
Appendix 5: Blank Task Analysis Form

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<thead>
<tr>
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<th>Condition:</th>
<th>Task:</th>
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**Movement Dysfunction(s)**

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<th><strong>Personal Factors</strong></th>
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<td>Social:</td>
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<td>Attitudinal:</td>
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**Physical Impairments**

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<th>Tests</th>
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**Conclusion**

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Appendix 6: Answer Key Task Analysis Form Case 2

| Name: V.D.V.N. | Condition: Right Total Knee Replacement | Task: Climbing Therapeutic Stairs |

### Movement Dysfunction(s)

#### Base of support:
- During weight acceptance she places her entire foot on the stair [Picture 1], feet are further apart and she leans against the rail with her buttock [Picture 2]

#### Alignment:
- During both stance and swing phase, she maintains a flexed position of her right knee and she positions her body sideways
- In the swing phase there is a lack of ROM in knee flexion

#### Sequence of Movement:
- Step to pattern
- Reduced speed
- Pulls herself up with the help of both upper limbs [Picture 3]

#### General Appearance:
- Sweating is observed on the face

### Environmental Factors

#### Physical:
- Four therapeutic stairs with two rails; height of stairs is lower than average

#### Attitudinal:
- Responds well to people around her during performance

### Personal Factors
- Motivated and cooperative; Fear and nervousness because she performs the task for the first time after the operation

### Physical Impairments

#### Tests
- **Strength**
  - Manual Muscle Testing
- **Endurance**
  - According to patient history
- **Proprioception**
  - Proprioception Test
- **Static Balance**
  - Standing static
- **Dynamic Balance**
  - Standing dynamic
- **Swelling**
  - Brush Test, Pitting Test, Circumference Measurement
- **Joint Mobility**
  - Goniometer Testing
- **Pain**
  - VAS-Scale

### Conclusion

After analyzing Mrs. V.D.V.N.’s performance of the task, the following is concluded:
- Pulls herself up with the help of both upper limbs: ↓ strength of knee extensors and flexors; also other muscle groups in the lower body could be weak
- Positions her body sideways: fear and ↓ROM in knee flexion; in this way she can put her entire foot on the stair to allow her more support for balance; to recruit more muscles on the left side of the body
- Leaning against the rail with her buttock: extra support for balance; compensation for ↓ strength of the right leg (due to operation) and the left knee (osteoarthritis)
- ↓ speed: pain, impaired coordination and ↓endurance
- Sweating: much effort is required to complete the task due to ↓endurance

Remark: Her positive and cooperative attitude has a positive influence on the performance of the task.

For revision of the videos: Frontal View and Saggital View
Appendix 7: Evaluation of the Study Manual

Students are requested to fill in the evaluation form at the end of the module and hand it in to Bob van den Berg. Through the students’ evaluations, the study manual can be expanded and modified in the following years.

| 1. The build up of the study manual is transparent. | 1 . . . . . . . . . . 10 |
| 2. Pictures are illustrative and relevant for comprehension of the text. | 1 . . . . . . . . . . 10 |
| 3. Views of the videos are clear. | 1 . . . . . . . . . . 10 |
| 5. The sequential phases are logical and useful for analyzing tasks. | 1 . . . . . . . . . . 10 |
| 6. The FTA form is easy to work with. | 1 . . . . . . . . . . 10 |
| 7. The FTA form contributes to the development of an analysis thinking process. | 1 . . . . . . . . . . 10 |
| 8. Appendices 1, 2, 3 and 4 provide relevant information. | 1 . . . . . . . . . . 10 |
| 9. The study manual is useful in this module. | 1 . . . . . . . . . . 10 |
| 10. The study manual is useful in this subject. | 1 . . . . . . . . . . 10 |

**Average Score (X/10)**
Other remarks: