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THE NEEDS AND REQUIREMENTS OF TECHNICAL AIDS FOR DISABLED PEOPLE WHO ARE OBESE

An Interactive Qualifying Project Report
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by

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Abstract

This project examines the needs and requirements of technical aids for disabled people who are obese. It was proposed to us by the Danish Centre for Technical Aids in København, Denmark. Our team examined the assistants of disabled obese people, and the following technical aids: wheelchairs, commodes, adjustable beds, hoists, and walking aids. The procedures employed were library and internet research, interviewing, and interactive observation. The results determined safer practices for assistants and modifications to problematic technical aids.

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1. Introduction

The percentage of the European and American population that is obese is increasing every year. The United States has the highest percentage of overweight men and women, while European countries such as Finland, Germany, Czech Republic, and Scotland trail closely behind. Obesity is an excess of body fat, frequently resulting in a significant impairment of health. Obesity results when the size or number of fat cells in a person's body increases. A normal-sized person has between 30 and 35 billion fat cells. When a person gains weight, these fat cells first increase in size and later in number. One pound of body fat represents about 3500 calories (Costian 1). To determine if a person is obese, a Body Mass Index, or BMI, is employed using the following formula: Weight (in kg)/Height (in meters) ^2. A BMI of 30 or greater is considered to be in the range of obesity. Since 1991 there has been a 10% increase in the number of obese people in the US alone, and the rest of the world is following this trend (Costian 1).

The field of *bariatrics* (italicized terms are defined in the glossary attached to this report), which is the branch of medicine that deals with the causes, prevention, and treatment of obesity, devotes significant attention to these increasing rates of obese people. *Bariatric* users and patients often require *technical aids*, that is, any product, instrument, equipment or technical system used by a *disabled person*, especially produced or generally available, preventing, compensating, monitoring, relieving or neutralizing the impairment, *disability* or *handicap*. New methods to handle the disabled obese people and new requirements for *technical aids* need to be adopted to allow this growing classification of people in the world to perform daily activities safely and comfortably.

The Danish Centre for Technical Aids for Rehabilitation and Education (Danish Centre) is the Danish national information and resource center in its field of study and research. Its aim is to contribute to the creation of equal opportunities for disabled persons within the areas of rehabilitation, assistive technology, special education, and ICT (information and communication technology) accessibility. The Danish Centre operates both on a national and international level, in co-operation with disability organizations, government authorities, institutions, research centers, clearing houses, local contacts in the field of rehabilitation and education, as well as manufacturers and suppliers (The Danish Centre). The Danish Centre has proposed a series of tasks for us to accomplish that will improve the practice of assistance and the lives of *bariatric* users and patients.

Our team sought out information about *technical aids* available on the market today. The categories of *technical aids* that were investigated include: manual and powered *wheelchairs*, *commodes, adjustable beds*, *hoists*, and *walking aids*. Additionally, the types of problems with these *technical aids* were explored, and modifications will be suggested. The *International Standards Organization (ISO)* and the *European Committee for Standardization (CEN)* only adopt standards for *technical aids* that support people less than 130 kg. The absence of an international standard leads to inconsistency and lack of quality in *technical aids*. Through research, we will find *technical aids* that are suitable for people greater than 130 kg.

In providing assistance to disabled obese people, nurses and home care staff run the risk of being injured. Some assistive devices require an assistant to help patients successfully operate the equipment. Typical cases where this aid might occur are in transferring, handling, or lifting disabled obese people. Our team investigated the methods that assistants use in aiding *bariatric* patients, and described the kind of modifications needed to prevent injuries to assistants.

This report will begin with a section on the background information. This section will include technical research on the following technical aids: manual and powered *wheelchairs*, *commodes, adjustable beds*, *hoists*, and *walking aids*. This section will also examine the theories and methodologies used in assistive care and also the problems that result from improper practice. The next section, our methodology, includes explanations of interviews and library and Internet research. Our results using these two methods include:

- a discussion of problems that *bariatric* users have with currently used technical aids;
- adaptations to the *technical aids* that requires modification;
- *technical aids* on the market that are suitable for the needs of *bariatric* users, which includes people greater than 130 kg; and
- problems with the handling/transferring of *bariatric* users in daily practice in e.g., home-care, nursing homes, or hospitals.

Finally, there will be supplementary materials that will include: a glossary of terms, interview documentation, and works cited.

2. Background Information

This section of the report develops a basic foundation of knowledge for the different types of technical aids that will be discussed in this project. It also describes the different types of risks and injuries associated with assistive care, along with possible solutions.

2.1 Technical Aids

Technical aids are any products, instruments, equipment or technical system used by a disabled person, especially produced or generally available, preventing, compensating, monitoring, relieving or neutralizing the impairment, disability or handicap (ISO definition). The main categories of technical aids that were investigated are: wheelchairs, commodes, adjustable beds, hoists, and walking aids.

2.1.1 Wheelchairs

A *wheelchair* is a device used for mobility by people for whom walking is difficult or impossible, due to an illness, injury or disability. It typically consists of a seat supported on two large wheels on an axle attached towards the back of the seat and two small wheels near the feet. There are often small additional features to prevent toppling or to assist in mounting curbs. The person moves by pushing the circular bars on the outside of the large wheels that have a diameter slightly less than that of the wheels (manual), or by actuating motors (powered).

With regards to disabled obese people, manual wheelchairs are best suited for those who are on the lighter side of the obese spectrum or who feel no discomfort in propelling themselves manually. The main categories of manual wheelchairs are lightweight/sport chairs, standard/everyday chairs, child/junior chairs, specialty chairs, and institutional/nursing home chairs. Specialty chairs and institutional/nursing home chairs are best suited for obese individuals. Specialty chairs are made to suit those with special needs, such as obesity, which require size and weight modifications to the wheelchair. Institutional/nursing home chairs are among the cheapest of wheelchairs. Their purpose is to transport patients with the help of an assistant. Institutional chairs are standard sized and not suited for obese people, therefore, specialty chairs will need to be used in institutional/nursing home environments for disabled obese people (ABLEDATA).

If obese people want to use a manual wheelchair, a realistic assessment of their abilities should be conducted. This evaluation should include a recording of the maximum distance a person can propel themselves, the type of floor surfaces encountered, and the time it takes to propel that distance. Assessing the person on ramped or pitched surfaces, as well as outdoor surfaces, is also helpful to determine the potential for manual mobility. A common misconception regarding manual wheelchairs is that the physical exertion required by the users is a substitute for exercise and is therefore recommended. According to Barbara Crane, PT, ATP, if the reason for selecting a manual wheelchair is for exercise then they should opt for a powered wheelchair and get their daily exercise in a different activity (Daus).

Until 1993, there were two basic styles of powered wheelchairs on the market: the traditional style and the platform-model powered chair. The traditional-style chair, the most common design in use today, is similar in appearance to a standard everyday wheelchair and is reinforced to tolerate the extra weight of a power and control system.

These chairs usually are powered by a battery attached behind or underneath the seat of the wheelchair. The platform-model powered chair consists of a seating platform located atop a power base. A variation on the power base concept is a chair that includes built-in lifts to allow the user to raise and lower the seating platform (ABLEDATA). A 1993 report, prepared by the Rehabilitation Engineering Center at the National Rehabilitation Hospital and entitled "Evaluating Powered Wheelchairs," suggests that the powered wheelchair selection process include an evaluation of the individual's physical status, functional capabilities, and usage requirements (Daus). Physical considerations include posture, strength, sensation, visual acuity and perception, and the ability to learn how to use the wheelchair safely. A functional evaluation should include the following concerns: the actual use of the wheelchair in everyday settings, an evaluation of the individual's ability to get in and out of the wheelchair, and the ability to perform needed activities from the wheelchair. Another factor that needs to be considered is a person's lifestyle. The process of selecting the ideal wheelchair for a disabled person with obesity will be to take all the factors, not just physical status, into account.

There are many aspects of the physical status of a bariatric user that needs to be considered. Soft tissue accumulation and weight distribution vary among bariatric users. A person may have a pear shaped body, which indicates gluteal-femoral obesity, or an apple shaped body, which shows abdominal obesity, and there are subgroups within each of these two major groups. Essentially, the way in which weight is distributed on a person will affect his or her comfort level in a given wheelchair. The person's height also dictates the height of the chair (Daus). Michael Dione, PT, suggests the following method to determine the classification of obese people: "The best way to determine which chair is appropriate for a patient is to get them on a solid surface such as a therapy mat or firm plywood and measure them. The goal is to simulate the posture they will have in a wheelchair" (Daus). When selecting the appropriate seat depth, measurements should be taken from the back of the buttocks to the back of the knee. However, if the bariatric patient has excess tissue surrounding the buttocks, a seat to accommodate this tissue would cause their upper trunk to lean back, which would then need to be supported with a backrest. One manufacturer has designed a bariatric wheelchair with a shelf in the back of the seat to accommodate this surplus of soft tissue (Galvin 30).

There are a number of issues and improvements that can be made to the bariatric wheelchair. A central issue is tailoring the chair for the home environment. The person will need to be able to get through doorways and onto van lifts. Most bariatric wheelchairs require a width of 86.36 cm to get through a doorway (Daus). Often, measures such as widening a doorway or hall to allow for a bariatric wheelchair to maneuver are necessary. Another problem is the floor coverings of the home environment. Carpets and other loose coverings can become a hassle to people in wheelchairs (Daus).

There are also improvements that have been made in the evolution of wheelchairs as well. For example, in the past, bariatric wheelchairs were designed as oversized standard chairs. Current designs focus more on durability and user-friendliness. Newer power chairs, which house the electronic mechanism below the seat, have benefited the bariatric population because a larger seat can be placed on top. This type of wheelchair can achieve an overall narrower profile while still meeting the seating needs of an obese person. This narrower profile can be compared to a manual chair in which the wheels are outside of the seating surface, creating a wider profile. Newer bariatric chairs allow people to adjust the width and depth, and remove backrests. A tilt-in-space position is also available for bariatric users with strong endurance for dynamic activity. In recent years, manufacturers have replaced air in the tires on many bariatric wheelchairs with solid urethane or other durable materials, which require less maintenance. An example of a modern bariatric wheelchair is sold by a company called Convaquip. This product stands out from the crowd because of its 294.78 kg weight limit. Other features of this product include flat free tires, a rechargeable battery-driven motor, and max speed of 5.5 mph. (www.convaquip.com).

2.1.2 Commodes

"Commode chairs (with or without castors) are chairs with a built-in collection receptacle used for toileting away from the bathroom; commode chairs [are] also used for showering" (Technical aids for persons with disabilities-Classification and terminology). A commode is a portable toilet for patients who are unable to use regular bathroom facilities (Figure 2.1). There are a variety of commodes on the market to meet patients' and users' needs. These include chairs with detachable arms, extra wide seats, heavy duty frames, wheels, foot rests, raised seating to fit over a toilet, and seat lift mechanisms. Extra-wide or heavy duty commode chairs are defined as those that have a width greater than or equal to 58.38 cm and are capable of supporting a patient who weighs 136.05 kg or more (The Regence Group).

Figure 2.1: Commode

A commode may be considered necessary when the patient or user is incapable of utilizing regular toilet facilities. Examples of this situation would be if the patient is confined to a single room or if the patient is confined to a home and there are not adequate toilet facilities on the first floor. Detachable arms may be necessary to aid in transferring the patient, or if the patient or user has a body configuration that requires extra width. The ability to detach the arms of the chair allows the commode to fit more easily into a small area, as well as giving the patient or user more room in the chair. Adjustable commodes are also available and are able to accommodate growth, lateral supports and footrests (The Regence Group).

A properly fitted chair disperses weight over the entire length of the thighs making sitting in the chair more comfortable. To accomplish this goal, footrests must be adjusted until the thighs are parallel to the ground. If the feet are too high, the weight is thrown back on the bony protuberances of the buttocks and can cause discomfort after long periods of sitting. If they are too low, the weight comes forward onto the thighs, causing pressure ulcers (VA Research & Development).

Armrests are used in multiple ways. They help positioning of the patient or user in the chair as well as transfers in and out of it. They provide extra comfort for the patients or users to rest their arms, as well as a structure to push down on to shift their position while in the chair and provide extra stability. Armrests also make moving the commode chair when the patient or user is not in it much easier. They act as handles that the assistants can use to lift the chair and move it to the proper position before transferring the patient or user into the chair. Based on these multiple uses, lockable pivoting armrests, capable of holding patients weighing upward of 100 kg and more, were designed. In the locked position, users and patients can pull up on the armrests without the fear that they will detach. Caregivers in institutional settings have identified the need and convenience for the two armrests to be able to swing away without being completely removable. Commode chairs now have a lever release mechanism that can lock and unlock the armrests. For added comfort, longer armrest pads have been incorporated to provide more surface area for the patient or user's arms and elbows (VA Research & Development).

The ability to adjust footrests in accordance with the height of the patient is critical in establishing a good seating position for bowel care. However, footrests typically require the use of tools for adjustment. The lack of adjustability is particularly problematic in institutional settings where multiple users are of varying heights. Since tools are seldom conveniently available on hospital units, footrests are rarely adjusted for the height of each patient. The lack of adjustment can force the patient to sit in an awkward position, predisposing him or her to an increased risk for pressure ulcers (VA Research & Development).

2.1.3 Adjustable Beds

An *adjustable bed* (Figure 2.2) is a bed with one or more sections of the mattress support platform that can be adjusted in height and/or angle (Dansk Standard 7). By adjusting the bed that an obese person is using, the large amount of pressure on that person's body, most notably their back, gets distributed properly. There are two main types of adjustable beds: manual and electric controlled. Manually controlled adjustable beds are suited for low weight capacity. Typically, there are cranks underneath the bed that control the adjustment. Most users do not have the ability to adjust a bed manually unless an assistant is present. Electric beds can be adjusted with a control or a set of controls while the person is lying on the bed (Galvin 220). Although they are more expensive than manually controlled beds, electric beds are often the ideal choice for obese people.

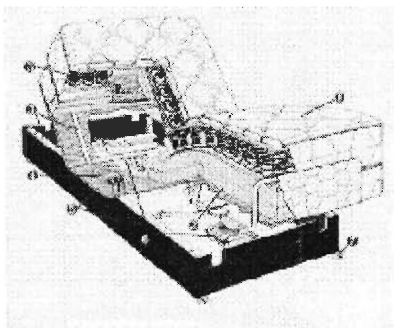

Figure 2.2: Adjustable Bed

The components of an electrically adjustable bed that require investigation are the weight capacity, mattress, adjustment capabilities, and transportation capabilities. Additional options are a trapeze (a horizontal cross bar used to help a bariatric user get in and out of a bed), a hoist, a scale, and a massage system. Each manufacturer's equipment has a specified weight limit from 272.2 kg to 453.6 kg (Cook 23). Two key features to include in a bariatric mattress are foam pressure reduction, which aids in alleviating pressure caused by the user's own body weight, and an adjustment-friendly mattress. Moreover, to determine the appropriate width of the bed, measurement of the patient in a supine position at their widest point is necessary. Wide beds are available in 99.06 cm, 121.92 cm, 137.16 cm, and 152.4 cm widths. A standard bed is 88.9 cm wide (Cook 26). A standard doorframe is 90 cm wide and if a bed that is greater then this width is used, modifications to the bed and/or doorframe will need to be made. Many beds have adjustable widths so they can fit through doorways. Although having a wide bed is desirable to provide space for turning the patient, it may pose patient care challenges for the staff that must reach across the bed to provide care. Very wide beds also take up extra space in a patient care room. If the patient is taller than 195.6 cm, the use of an extra long (218.44 cm) bed is required (Cook 76).

The main positions used on an adjustable bed are Trendelenburg, cardiac chair, and fowler positions. In Trendelenburg's position the patient is on an elevated and inclined plane, usually about 45°, with the head down, and legs and feet elevated. This position is only used to treat patients in shock, and is never used on a bariatric patient due to the already present cardiac problems. The cardiac chair position is used when the patient needs to be propped up at a 45° angle to relieve cardio respiratory distress. In Fowler's position the head of the bed is elevated to the desired height, about 60-90 cm, to produce angulations of the body, usually 45° to 60°. The user's knees may or may not be bent in this position. Fowler position is used to facilitate breathing for the comfort of bedridden patients while eating or talking (Cook 118). The bed must also have transportation capabilities if it is in a nursing home or hospital environment. Heavy-duty *casters* are installed which allow for easy and maneuverable transportation.

2.1.4 Hoists

A *hoist* is a lifting and transferring device for raising disabled people with the use of a sling. The main categories of hoists that are covered in this report are: *stationary hoists* and *mobile hoists*.

2.1.4.1 Stationary Hoists

A stationary hoist is "a hoist with which a person is lifted, transferred or moved within a pre-defined area and which is fixed to a wall, ceiling or floor, or is mounted in or on other allied devices, or is free standing" (European Committee for Standardization). There are generally three types of stationary hoists: *ceiling-mounted*, *fixed*, and *free-standing hoists*.

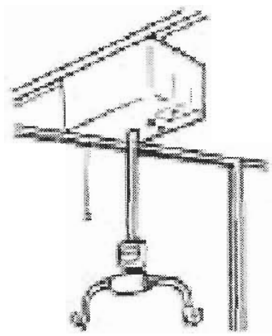

Figure 2.3: Ceiling-Mounted Hoist

A ceiling mounted hoist (Figure 2.3) is "an overhead mounted hoist system fixed to the ceiling or wall(s), including a tracking system" (European Committee for Standardization). Its basic operation involves vertical and lateral movements on rails fixed to the ceiling. Depending on the model, the hoist can move along these tracks electrically or manually. The hoist works by lifting a person, with the assistance of another, using a sling dangling from the ceiling and is then moved along the ceiling-mounted rails to the destination. The rails can either be permanently mounted to the ceiling or attached to support posts (JETRO).

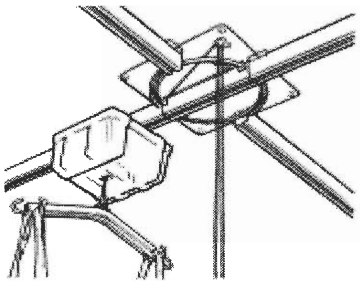

Figure 2.4: Turntable

There are several different types of tracking systems available such as *straight tracks*, *angled tracks*, *X-Y tracks*, and *turntables*. A straight track carries the hoist in only one direction from one place or room to another. An angled track has different tracks that are angled to allow the hoist to go around corners and bends. However, the angled track has difficulty negotiating 90° turns. Turntables enable the hoist to negotiate a 90° turn by pushing a button or using a pull cord that releases a mechanism that swivels the hoist 90°. Figure 2.4 depicts the turntable allowing the hoist to move onto a track running in a different direction (Disabled Living Foundation).

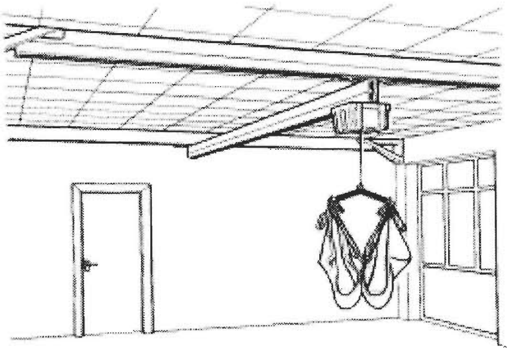

Figure 2.5: X-Y Tracking System

An X-Y tracking system (Figure 2.5) allows the hoist to lift a person from anywhere in a room. This mobility is accomplished by making use of two parallel tracks on each side of the room either on the ceiling or on opposite walls. A moving section of track then runs between the parallel tracks, which give the hoist its complete range of movement (Disabled Living Foundation).

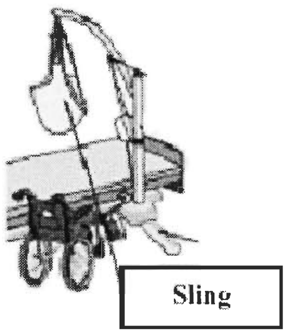

Figure 2.6: Fixed Hoist

Another type of stationary hoist is a fixed hoist (Figure 2.6). A fixed hoist is permanently installed in living rooms, bathrooms or other locations, and a sling or seat is used to lift and transfer the individual from one location to another. This type of hoist is used to move patients in a set parameter if they are not able to move on their own.

Depending on the model, a fixed hoist can operate under electrical or manual power. In the case of manual power, the arm is typically mounted on the wall and a manual rope is used to lift the individual. Joints in the mechanical arm help increase the range in which a person can be transferred (JETRO).

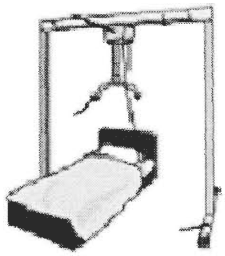

Figure 2.7: Free-Standing Hoist

A free-standing hoist (Figure 2.7) is another type of stationary hoist. It rests on the floor and uses a sling or a seat to lift and transfer the individual within the mobile range of the unit itself. There are also the cases where an electric-powered lift mechanism is attached to rails in the shape of an arch in the four corners of the room, lifting and moving the individual laterally along the rails. The rails are fixed in place directly above the location where the individual needs to be moved, such as a bed or a bathtub (JETRO).

2.1.4.2 Mobile Hoists

A *mobile hoist* is fitted with wheels that can move freely along the floor, and with which a disabled person is lifted and transferred independently of a fixed installation (European Committee for Standardization). There are several types of mobile hoists, which include standard mobile hoists, standing hoists, and mobile seat hoists. A mobile hoist is made up of four main parts: the *castors*, the *mast*, the *boom*, and the *spreader bar* (Disabled Living Foundation, Independent Living Centre NSW Inc). The castors are the bottom support of the hoist where the wheels are located. The mast is the vertical support that incorporates the lifting mechanism. Depending on the model this mechanism can be a hydraulic pump, winding handle, or battery powered. The boom extends from the mast and provides the horizontal reach. Some booms are angled which increases its ability to lift from the floor, also allowing the person in the hoist head clearance and a 360° of rotation when suspended. The spreader bar is located at the end of the boom and provides the width to span the shoulders of a person and the attachment points of hooks for the slings. (Disabled Living Foundation).

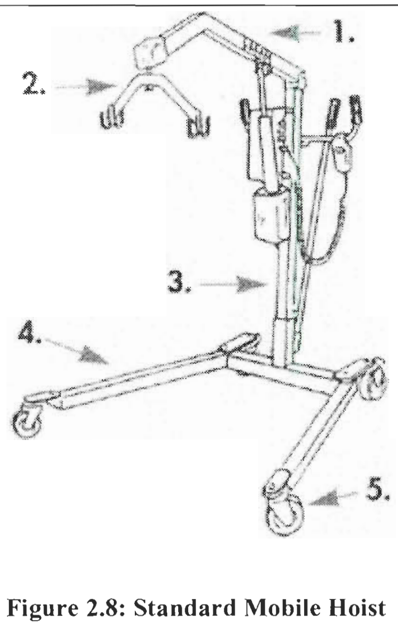

Figure 2.8: Standard Mobile Hoist

1. Boom
2. Spreader Bar
3. Mast
4. Base (usually width adjustable)
5. Castors

A standard mobile hoist (Figure 2.8) is used to lift and transfer a person to a different location. Operation of these types of hoists require the assistance of another person, independent of the person in the hoist. A standard mobile hoist has a mobile base and a sling that is used as a lifting mechanism.

There are typically two size categories for the standard mobile hoist: small and large. Small hoists have a small and narrow base and can only provide a maximum lifting capacity of 100-140 kg. Large hoists are generally wider, longer, and taller than the small hoist and can typically provide a maximum lifting capacity of 160-250 kg (Disabled Living Foundation).

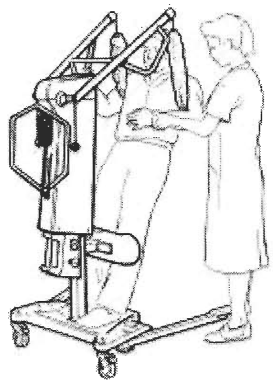

Figure 2.9: Standing Hoist

Another type of mobile hoist is a standing hoist (Figure 2.9). It has a mobile base, which in most cases has a footrest, and is available as manual or electric powered. Standing hoists make use of a specifically designed sling arrangement, which is usually narrow and positioned under the arms of the user. The person is hoisted into a semi-standing position, sitting halfway down and angled back, allowing the person proper access to their undergarments to use a toilet (Disabled Living Foundation). The standing hoist can also use a special toileting sling that allows the user proper access and support to use the toilet.

Standing hoists should only be used by people who can hold some of their weight with their legs as the sling lifts them from a seated into a semi standing position. To help address this problem, some models of the toileting or standing hoist have the option of a seat if the person is to be moved a significant distance. In this case, the person in the hoist would be lowered onto the seat before being moved. In general the toileting or standing hoist is of larger size (Disabled Living Foundation).

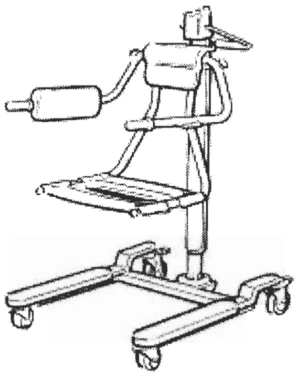

Figure 2.10: Seat Hoist

A mobile seat hoist (Figure 2.10) is generally used for the purpose of bathing, making use of a seat, or in some cases a stretcher for the person to lie on. Mobile seat hoists are available in manual and electrical powered models. Since seat hoists provide less support than a sling they require that the person have reasonable sitting balance. If someone is unable to sit, there are some models with a stretcher for the person to lie down on (Disabled Living Foundation).

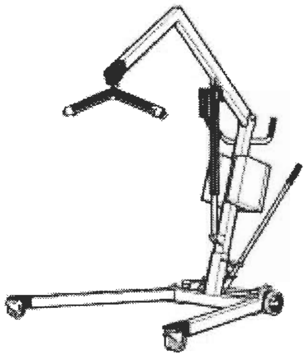

Figure 2.11: U-Shaped Base

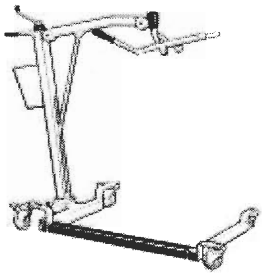

Figure 2.12: C-Shaped Base

A component of a mobile hoist that can affect its performance is the base. The length of the base can affect its stability and ability to maneuver. The longer the base is, the more difficult it is to maneuver, but this added length adds strength and stability. The same can be said about the width of the base, which in some models can be adjusted. Figures 2.11 and 2.12 show the two types of bases, U-shaped and C-shaped that can be used. The majority of the mobile hoists have a U-shaped base, while there are some mobile hoists that have a C-shaped base. The advantage of the C-shaped base is that the boom and spreader bar are brought in from one side, reducing the feeling that the spreader bar will touch the person being moved. (Disabled Living Foundation)

There are generally three types of lifting mechanisms on mobile hoists: hydraulic pump control, winding handle control, and battery powered control. The pumping action of a hydraulic pump control can be a tiresome task, especially as the angle between the mast and boom increases. Hydraulic pump controls also lend themselves to be a jerky ride for the person in the hoist, adding discomfort. The height of the handle can also be positioned too low on some hoists, adding inconvenience to the person operating the pump (Disabled Living Foundation).

A winding handle control provides the person in the hoist with a much smoother lift, but is considerably more difficult for the person operating the hoist. It would be very difficult to hoist an obese patient using a winding handle control. Some winding handles are positioned on the top of the mast, which means that the person operating the hoist must have good shoulder strength. When the winding handle is positioned on the top of the mast, it puts the operator in a poor posture, especially if they are of shorter stature (Disabled Living Foundation).

A battery powered control requires hardly any effort from the operator when lifting the patient, but the added weight of the batteries can make it more difficult to maneuver. With some models the controls to the lift are on a remote, which allows the people in the hoist to operate the lift while the assistant helps position them (Disabled Living Foundation).

2.1.5 Walking Aids

Walking aids are products that help mobility impaired persons move within their environment and give them independence in personal transportation. The walking aids discussed in this report include elbow crutches, *walking frames*, *rollators*, and *walking sticks* with three or four legs.

2.1.5.1 Elbow crutches

Elbow crutches are generally used by those who are able to partially support their own weight. In the case of double adjustable elbow crutches, both the floor-to-handgrip height, along with the distance between the cuff and the handgrip are adjustable. Single adjustable elbow crutches only allow for the floor-to-handgrip height to adjust. Some elbow crutches even have the option of standard or molded handgrips (Disabled Living Foundation).

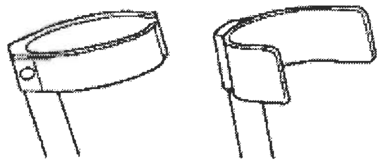

Figure 2.13: Closed and Open Cuffs

There are two styles of cuffs (Figure 2.13) that an elbow crutch can have; either open or closed. The open cuff style is semi-circular in shape and allows support for the forearm to brace against while walking. A closed cuff is an incomplete ring, which prevents the forearm from slipping out of place along with keeping the crutch securely on the arm. The closed cuff style can be used to open a door without removing ones arm from the crutch since it will not slip off the person's arm. (Disabled Living Foundation).

2.1.5.2 Walking frames

Walking frames incorporate the use of four legs, which add stability, to help aid a person walking. There are two types of walking frames: non-wheeled frames, and wheeled frames. Standard non-wheeled frames are commonly referred to as Zimmer frames and are generally used indoors (Disabled Living Foundation).

Figure 2.14: Walking Frame (Zimmer Frame)

The standard Zimmer frames (Figure 2.14) are typically constructed of metal using either aluminum or steel. Rubber ferrules are used on the bottom of the four legs to prevent slipping. The handgrips are either made of molded plastic or foam rubber. To help evenly spread the pressure exerted through the hands, it is possible to get models with contoured handgrips. There is also the option of a forearm rest, which allows the person to bear their weight through their forearms rather than just through their hands. These forearm rests are padded, vinyl covered, trough shaped supports with vertical handgrips. The length and angle of some handgrips can be adjusted to achieve the most comfortable position for the user. Alternatively, some have a platform on which to rest the forearms and a vertical handgrip rather than individual rests (Disabled Living Foundation).

Some models of walking frames allow for the height to be adjusted, while other models are at a fixed height. Non-wheeled frames are very useful in providing a large area of support, but can be very inconvenient since the natural flow of the walking pattern is disrupted. It forces the user into a stop and go pattern while having to pick up the frame. This type of walking frame might not be ideal for an obese person (Disabled Living Foundation).

2.1.5.3 Rollators

Rollators have the same basic frame as a walking frame, but instead of rubber ferrules these frames have a four-point base with wheels (Figure 2.15). The castors and/or wheels are not always fixed in one direction and therefore they have a greater degree of maneuverability. They are larger than more standard frames and are suitable for outdoor use. The handgrips may also vary. For example, there are pushing handles, horizontal bars, or integral grips. The design of the handle and the position of the extras, such as baskets and seats, will determine whether the frame is pushed along from behind or stepped into. If the frame is stepped into, it will offer the user more support (Disabled Living Foundation).

Figure 2.15: Rollator

2.1.5.4 Walking Sticks

These walking aids have a walking stick style shaft and a three or four point base. They are therefore freestanding and are more stable than standard walking sticks. They are usually used individually rather than in pairs. If they are used in pairs, the narrow base styles are used, and occupy less floor space making them more practical than the broader styles (Disabled Living Foundation).

Figure 2.15: Four Point Walking Stick

Tripods and quadrupeds are available in narrow and wide based versions, the wide base offering greater stability. Figure 2.15 shows an example of a quadruped style of walking stick. All can be used right or left-handed. The handgrip can also be rotated 180° so that the spread of the base is away from the user.

Some tripods and quadrupeds incorporate an extension above the handgrip that terminates in an elbow cuff, similar to the cuff found on elbow crutches. This design gives added security by retaining the forearm in a position immediately above the handgrip (Disabled Living Foundation).

2.2 Assistants and Nursing Staff

Interactions between patients and staff are virtually unavoidable. These interactions can take place in hospitals, nursing homes, or during home care. As the number of interactions increase, it is more likely that technical aids will be used. The daily routine of a nurse often requires lifting heavy loads, working in awkward positions, transferring several patients, and operating potentially hazardous equipment (Trinkoff, *Musculoskeletal Problems* 171). The most common tasks performed by nurses include repositioning patients in bed, transferring patients between beds, stretchers, and wheelchairs, and moving patients in and out of ambulances (Lynch 291). All these actions lend themselves to the use of technical aids.

2.2.1 Risks and Problems

Like any job, nursing can be potentially dangerous. The potential for risk begins with the environment. Nurses in orthopedic, rehabilitation, geriatric, and surgical wards are the most at risk for obtaining injuries on the job, due to the large amount of assistant-patient interaction (Walls 380). To add to the risk, changes in health care have decreased the number of staff on duty while increasing the patient load. Each of these factors has been shown to increase the rate of injury among nurses (Trinkoff, *Musculoskeletal Problems* 171). With an increased patient load, nurses are more likely to perform hazardous activities several times in one shift. These hazardous activities include performing patient transfers, which often require the assistant staff to work in awkward positions. Studies correlating forces and bodily loads have demonstrated the danger of injury of working in awkward positions as well as performing patient transfers and repositioning (Trinkoff, *Perceived Physical Demands* 274). This risk of injury increases as the weight of the patient increases. Lifting patients weighing over 54.43 kg exceeds the strength capability of most female nursing assistants (Lynch 290). It has been shown that lifting and transferring patients are the primary causes of injury among nursing personnel (Daynard 200).

Lack of training, and non-compliance with handling procedures, has shown to result in spinal loading that is risky, according to suggested limits (Daynard 213). One of the most common activities associated with back injury is the adjusting of a patient bed. Manually raising or lowering the height of the bed, and making a bed at the incorrect height are substantive additives to an assistant's back strain. When a bed is set low enough for a patient to easily enter and exit, the assistant must bend more to perform the required activities. The maintenance status of the patient bed, whether it is manual or electric, is also a factor in back strain among assistants (Walls 380). If the electric bed is not properly maintained, the movements will take longer, requiring assistants to be in awkward positions longer. When more time and a greater number of activities were required to complete the patient handling activity, a higher *cumulative spinal load* was observed (Daynard 210).

The physical demands of nursing often lead to back injuries. The risk of back injury is particularly high during patient transfers. They require sudden movements in awkward positions, as well as flexion and rotation. The combination of compression, rotation, and sheer forces increases the risk of injury (Trinkoff, *Perceived Physical Demands* 270). Most health care facilities have protocols put in place for patient transfers that are meant to reduce the risk of back injury. The most common reasons for non-compliance with patient handling procedures among assistants were shortage of staff to assist, increased time required for equipment use, accessibility of equipment, and support from the management (Daynard 209). When compliance rates drop, injury rates increase.

Studies have revealed strong evidence that lower back disorders are associated with work related lifting, awkward postures, heavy physical work, and forceful movements (Walls 383). Seventy-three percent of back injuries among health care workers are due to lifting and transferring patients (Lynch 290). A high prevalence of occupational back injuries has been documented in nursing personnel, with the greatest incidence noted among those who were exposed to frequent patient handling (Daynard 199).

2.2.2 Injuries

Health care workers have among the highest rates of back injuries. The specific factors identified as being related to the onset of back pain include a history of back injury, recent job change, overtime, and heavy manual work (Walls 382). Cumulative load exposure predisposes the spine to pain and or injury, and is therefore a risk factor for back injury. *Cumulative spinal loading* is defined as "the accumulated demands on the spine during the duration of a single-patient-handling activity" (Daynard 200). This injury is a particular problem for nursing staff since they repeat similar activities several times throughout a shift. The demands on the spine from the individual activities eventually build up to unsafe levels when more activities are continually performed. One of the most common injuries among nurses is *musculoskeletal disorder* (MSD). This injury can affect any area of the body where increased stress is applied. Registered nurses ranked sixth overall for work related MSD cases in private industries, with 12,400 reported injuries requiring a median of 5 days lost from work. Among all non-fatal occupational injuries, nursing and personal care facilities ranked second, and hospitals ranked sixth (Trinkoff, *Musculoskeletal* 170). A case of MSD is defined as "pain, numbness, tingling, aching, stiffness, or burning that has lasted at least one week, or occurred at least monthly in the past year, with a pain intensity of at least 3 (moderate) on a 5 point pain scale" (Trinkoff, *Musculoskeletal Problems* 171-172). The three most common areas for MSD to occur are the neck, shoulders, and back. In a survey of MSD injuries among nurses, 31-48% reported having a neck MSD injury, 43-53% reported having a shoulder MSD injury and 30-60% reported having a back MSD injury (Trinkoff, *Musculoskeletal* 170). Manipulation of patients in and around patient beds fulfills all the criteria of work-related MSD cases (Walls 383). Furthermore, stooping and lifting were two of the actions that were significantly associated with arm and neck complaints. Any heavy lifting and actions with the arms above shoulder height have also been associated with shoulder pain or injury (Trinkoff, *Perceived Physical* 271). Most patient lifts and transfers consist of a series of actions, with each contributing a different amount of biomechanical stress (Daynard 200). This series can cause the number of actions required to begin to accumulate, as well as the time needed for the transfer to increase. As mentioned earlier, these two components are two of the contributing factors to back injuries.

2.2.4 Results of Injuries

The most common results of injuries in nurses include missing work, reducing work activities, taking medication, changing jobs, and losing sleep. Of those reporting a MSD neck case, 15.7% missed work, 30.8% reduced their work activities, and 92.3% began taking NSAID medications. Of those reporting a MSD shoulder case, 45.7%

missed work, 38.7% reduced their work activities, and 92.9% began taking NSAID (Non-steroidal anti-inflammatory drugs) medications. Of those reporting a MSD back case, 26.3% missed work, 46.8% reduced their work activities, and 92.9% began taking NSAID medications. Twenty percent of nurses who reported back pain made at least one job change to reduce their required lifting and transferring of patients. There is also a link between MSD cases and an increased likelihood of inadequate sleep among nurses (Trinkoff, *Musculoskeletal Problems* 171-176). Inadequate sleep has been linked to the quality of life, psychological well-being, and performance on the job for nurses.

2.2.5 Solutions to Risks and Injuries

Solutions to reducing the risk of injury to assistants and nursing staff include education, training, and the proper use of assistive equipment. Unions, health care facility managers and regulatory agencies have initiated programs to address the causes and reduce the severity of back injuries among health care workers (Lynch 290). The most common approach to the prevention of lower back injuries has been education and training in biomechanics and lifting techniques. In studies where two groups of staff were asked identical questions about risk factors for back injuries, the staff that was previously trained on average answered 7.9 (out of 10) questions correctly, whereas the staff that was not previously trained on average only answered 6.6 questions correctly. This difference is significant with a probability equal to 0.01 (Lynch 292). The use of intervention methods and programs has been found to reduce spinal loads to a level that is below concern (Daynard 210). Increased and more thorough trainings help educate staff to make the correct transferring decisions.

A compliance study performed with two patients of different weights showed that nurses are more likely to comply with intervention protocols when there is a greater perceived risk of injury associated with the transfer (Daynard 208). The two patients weighed 55 kg and 100 kg. Even though a patient may not be overweight that does not mean that there is no risk. However, compliance with transferring procedures was significantly greater during the handling of the heavier patient. Furthermore, the most transfers conducted correctly were performed by those who were part of a back injury prevention program (Daynard 201-204). Nurses and assistant staff should be aware of the risk, regardless of the weight of the patient.

Significant results are seen in preventing MSD cases and symptoms in nurses by reducing physical demands through the use of mechanical lifting devices and no-lift policies (Trinkoff, *Perceived Physical* 274). The use of electric patient beds appears to reduce the number of unsafe lifts and could contribute to reducing back injuries among nurses. However, there were more complex patient/nurse interactions occurring around the bed (Walls 383). These complex interactions lend themselves to a greater number of actions needing to be performed as well as more time needing to be allotted for the action. Although the risk is decreased, the amount of time and actions could be detrimental in other areas. When a bed to wheelchair transfer of a 55 kg patient is completed with assistive equipment, significantly lower peak compression values are seen (Daynard 205). The incorporation of new assistive equipment into already existing injury prevention programs resulted in higher compliance with the programs (Daynard 213).

Increased time associated with the use of assistive equipment is a legitimate concern. Bed to stretcher transfers were significantly longer when assistive technology was used (Daynard 209). In many cases, the use of assistive equipment increases exposure to problematic prolonged spinal loads, since more actions are required to complete the transfers. However, compression results in transfers demonstrated reductions in peak spinal loads with the use of assistive patient-handling equipment (Daynard 210). Unaccompanied by other significant back sparing interventions, it does not appear that certain technical aids such as electric patient beds will, by themselves, significantly reduce the overall risk to nurses of lower back disorders and the overall cumulative injury rate (Walls 383). These assistive technologies must be combined with other aspects of prevention such as education and training.

Body mechanics and back care training are only effective at injury prevention when they are combined with an ergonomic approach, which results in a change in job demands (Daynard 200). When the demands of the assistive staff are changed, fewer dangerous activities are performed. Education, technique training, and new assistive handling equipment have been shown to reduce spinal loading in several tasks (Daynard 213). Equipment and environmental factors are also important contributors to patient transfer behaviors (Lynch 294). All these factors must be considered and addressed together in order to achieve the largest decrease in injuries to assistants and nursing staff.

2.3 Standards

The *ISO* and *CEN* standards consist of testing and technical requirements for technical aids. Since this project deals with investigating technical aids and determining problems associated with them, using European and international requirements as a relevant facet of our research would not be directly applicable. However, many of the standards contain useful definitions of various types and components of technical aids that our team found relevant. Furthermore, The Danish Centre recommended that the standards were not the primary focus of this project, and they should not be used as a major source for the background information.

3. Methodology

A sufficient amount of background information was gathered, which explained the technical aspects of the assistive devices, and the risk, injuries, results of injuries, and possible solutions to assistive care. With a strong foundation of information, the next objective was to establish methods that will serve as tools in solving our given task. The outcome after implementing our methods was that we:

- Identified problems that bariatric patients and users have with currently employed technical aids;
- Determined solutions for the technical aids that require modification;
- Found technical aids on the market that are suitable for the needs of bariatric patients and users;
- Found technical aids for overweight people (above 130 kg) available on the market today; and,
- Identified problems with the handling/transferring of bariatric patients and users in daily practice in places such as home-care, nursing homes, or hospitals.

3.1 Library and Internet Research

Library and Internet Research is a technique for drawing inferences from existing records or documents in a systematic and unbiased way. This method aided in investigating problems that bariatric patients have with currently used technical aids. This investigation was done primarily through the World Wide Web, which identified up to date issues that bariatric patients and users have. The Web also helped in finding technical aids for overweight people above 130 kg. The disadvantage of Web research is that some of the information may be biased. To solve the issue of biased resources, we consulted a variety of different sites to ensure the information that we used was valid. The Web also served as the primary tool in finding manufacturers that sell assistive devices to bariatric patients and users. Search engines and databases helped find the desired technical aids. Searching for technical aids was only done after we found problems with currently used equipment. We also searched for technical aids on the Danish Centre's database of technical aids. Using their database allowed us to perform advanced searches that yielded specific results. For example, we were able to find manufacturers that sell wheelchairs with a 1000 lb. weight limit, adjustable seat depth, adjustable foot rests, etc.

3.2 Interviews

Conducting an interview is one way to obtain information. Interviews can be used to evaluate the effectiveness of a program or piece of equipment, as well as to document expert opinions. The purpose of an interview is to elicit responses from the interviewee that are pertinent to the research being conducted. The structure of the interview is defined by the order and wording of the questions. An interview can be structured, in which the interviewer asks specific, concrete questions in a specific order. It can also be open-ended, in which the format is less formal, and the questions encourage the interviewee to elaborate.

The most useful way to obtain information about the needs and requirements for technical aids is to talk to those most closely related to the relevant fields of study. While still in the United States, one interview was conducted with a professor of Mechanical

Engineering, Holly Ault. While in Denmark interviews were held with members from a department of technical aids in Rødovre Kommune, the head of safety at Bispebjerg hospital, a manufacturer and dealer of technical aids who focus on those for overweight people, and a physical therapist who works for Rødovre Parkvej, a consulting organization for municipalities and citizens. Conducting these interviews provided insight into the three most important aspects of technical aids.

These interviews were conducted using a combination of the structured and open-ended formats. There was a list of prepared questions to use as a general guideline, but the interviewee was allowed to elaborate. At the beginning of the interview, there were a few extra, ice-breaking questions to establish the atmosphere and keep the interviewees at ease. These questions included the amount of time they have been working in their current job, and their level of expertise. As the interviews continued, essential questions were asked to direct the interview toward the specific topic of technical aids for bariatric patients and users. These were followed by open-ended questions, on the same topic, allowing the interviewees to elaborate on their own. More probing questions were then asked as follow-ups to extract more information. Our methods for gathering the information from the interview included note taking, as well as the use of a tape recorder, with the interviewee's permission. The questions pertaining to each interview can be found in Appendix A.

There is not much information already published about the problem at hand. By utilizing interviews, a plethora of information was gathered about the problems and aspects of technical aids for bariatric patients and users. For instance, we discovered many mobile hoists require larger wheels for easier transportation. If a larger wheelbase is implemented, the larger wheels will not be able to fit underneath a bed in order to lift a patient (Petersen). This example illustrates the circle of problems that can occur when trying to modify technical aids to accommodate bariatric users and patients.

3.3 Interactive Observation

One approach to conducting field research is interactive observation. Field research is defined as "the study of people acting in the natural courses of their daily lives" (Nachmias 281-282). By using interactive observation as a method, we were able to not only observe one subject in her natural environment, but we were also able to question the subject. In cooperation with Rødovre Kommune, we observed an obese disabled woman in the home environment. We examined and tested the technical aids that she requires to perform daily activities. These aids include a powered wheelchair, a mobile hoist, a commode, a sling, and an adjustable bed with a turning sheet. Furthermore, we examined what adaptations needed to be done to her apartment so she could function comfortably on a daily basis. We also inquired about her living status, that is, the problems she has in the home environment with being assisted or with the technical aids themselves. For example, the subject had difficulty maneuvering around her bathroom due to the small dimensions of the room, and the commode took up a lot of space. By observing the environment and the subject in that environment, we were able to see and understand the practicality of our project.

3.4 Synthesizing Observations into Results and Analysis

After documenting the information we received from the interviews into structured synopses, we extracted the valuable and pertinent findings. These results included problems with technical aids and the transferring/handling of bariatric patients, as well as solutions and recommendations to many of these problems. We organized our findings into the following categories: technical aids including wheelchairs, commodes, adjustable beds, hoists, walking aids, and other issues with equipment; and transferring/handling with the aid of an assistant. Once our results were in their respective categories, the bulleted information was transformed into structured paragraphs, which clearly describe the problems and solutions associated with technical aids and transferring/handling with the aid of an assistant.

4. Results and Analysis

This results and analysis section is an accumulation of information gathered from the interviews conducted. The first interview took place at Rødovre Kommune with Karen Clayton. After our initial questions were answered, we visited the warehouse that stores the technical aids for the Kommune and spoke to Henrik Sørensen, manager of the warehouse. We then proceeded to visit Ellen Poulsen, a bariatric user, at her home. The second interview was with Keld Jørgensen, the owner of Cobi, a small company that, among other things, imports and manufactures technical aids for obese users and patients. Our questions were answered, and a short tour of the small building was conducted to show us the various technical aids the company supplies. The third interview took place at Bispebjerg Hospital where we spoke with Nicolai Wiese who is the head of the economics department, and organizes the in-house physical therapy program. Lastly, we conducted an interview at Rødovre Parkvej where we spoke to one of the physical therapists, Mary Petersen. Through compiling the information gathered from the interviews conducted, synopses of the interviews (located in Appendix B) were organized from which the information presented in this section was extracted.

4.1 Problems with Technical Aids

Bariatric users and patients face a number of problems with daily activities that we take for granted. In order to complete these activities they must implement the help of technical aids. Unfortunately, obese people also experience problems with these aids. Most of the problems stem from an obese person's unique body structure. Due to the extra weight distribution in obese people's stomach and lower hip region they experience very poor balance. They must also deal with pain in their hips and knees because of the extra weight that their joints and bones must endure.

The most typical day to day problems that disabled obese people encounter are walking, bathing, getting in and out of bed, getting through doorways, and not having adequate enough space in the rooms of their homes (e.g., bathroom). One of the most common problems they face with technical aids on the market is that they do not fit properly. The products that are made with higher weight capacities are usually "normal" aids that are modified to be larger and stronger. These slight modifications to existing technical aids do not always solve all of the structural problems with the technical aids (Clayton, Jørgensen, and Wiese).

4.1.1 Wheelchairs

There are several problems with wheelchairs currently on the market today. These problems become more evident when a bariatric patient or user is using the aid. In the case of wheelchairs the bearings on the wheels cannot support the extra weight and are often the first part to break on bariatric wheelchairs (Jørgensen). If not reinforced, the armrests and footrests can also be weak points on the wheelchair. They cannot support the extra pressure when obese users or patients put all of their weight on them to adjust their position. Under this increased load the parts tend to bend or break (Jørgensen and Clayton). As the load in the chair increases, the rear wheels, which tend to be made of a soft rubber, cause a large amount of friction with the surface when moving (Petersen). A possible solution to this problem would be to use a harder, denser rubber, which would hold its shape and result in less friction with the surface. The disadvantage of using a harder material is that the shock absorption of the wheelchair will decrease causing the overall comfort factor of the wheelchair to also decrease (Petersen).

Different problems occur for obese users when implementing the use of a manual wheelchair verses a powered wheelchair. A problem that occurs specifically with manual wheelchairs is that the obese person has a very difficult time moving the wheelchair. Since the bone structure of obese people does not change and increase with their weight, they have to get their arms around their extra weight in order to move the wheels. This position causes a significant loss in their range of motion, only allowing them to accomplish very small pushes of the wheels (Clayton and Jørgensen). In turn, this motion can result in shoulder injuries in bariatric users who operate manual wheelchairs (Clayton). These injuries are caused by the unnatural positioning of the shoulder joints when attempting to propel the wheelchair. Another potential problem with manual wheelchairs is the large amount of force that is required to move at an adequate pace. A simple solution would be to move the patient or user to a powered wheelchair. However, the motors on powered wheelchairs tend to break down more frequently when used by obese users because the motor was designed for a lighter person (Clayton).

The most common modification needed for wheelchairs in order for obese users and patients to use them is to widen the seat. Increasing the seat width of the wheelchair to accommodate an obese user or patient increases the total width of the wheelchair. This extra width causes problems when attempting to fit the wheelchair through doorways or maneuvering around the home. Karen Clayton was under the impression that users with wheelchairs wider than 63 cm (43 cm seat width) would be unable to utilize public transportation. However, through further research, it was discovered not to be the case. Extra wide wheelchairs are able to fit onto public transportation vehicles, and obese users can utilize this convenience as long as the wheelchairs can still be safely secured to the vehicle. Of course, fewer extra wide wheelchairs will be able to fit into one vehicle than compared to the number of standard wheelchairs.

The most economical wheelchair is not always the most practical. The cheapest wheelchairs are those that are able to fold for storage purposes. These types of wheelchairs are mostly found in institutional situations, but can also be used in the home environment if it is only for a short period of time. In order for the wheelchair to be able to fold up, the seat must be soft and cannot be supported from underneath. This design can cause a problem when an obese user or patient sits in the wheelchair due to the excessive amount of weight being placed on the flimsy seat. The seat begins to cave in, causing a lot of pressure to be placed on the user's hips and pelvis, which is very uncomfortable (Clayton, Jørgensen, and Wiese).

When customizing wheelchairs for bariatric users, the knowledge of a physical therapist is needed. The physical therapist must determine where the user's pelvic bones are so that the width of the wheelchair can be appropriately determined (Petersen). If the width of the wheelchair is based on the measurements of the user's waist, and not their skeletal structure, it will not provide the proper support. Selecting the appropriate width of a wheelchair should instead be based on where the user's pelvic bones are located. In some cases the pelvic bone is oblique, i.e., one side is lower then the other. It is very important to make sure the pelvic bone is manipulated by the therapist and in the proper position before measuring for the width of the seat. The problem essentially lies in accurately finding the location of the pelvic bones due to all of the excess weight around that area (Petersen).

Another therapy-related issue is the unnatural positioning of bariatric users' legs due to the excessive amount of extra weight on the inside of obese users' legs. This extra weight causes their legs to naturally be more spread out when sitting. This unnatural position is not conducive to a healthy pelvic area. As mentioned in the previous paragraph, if the pelvic area of an obese user is not in the proper position, further problems will precipitate when dealing with technical aids (Mary Petersen).

Keld Jørgensen gave us the contact information for one of his employees Anne Katherine Skifter, who directed us to the website, www.bariatricrehab.com. There, we discovered a detailed description of how to properly fit an obese person for a wheelchair. This description can be found in Appendix C.

4.1.2 Adjustable Beds

Every patient care facility has adjustable beds. When patients are sent home they may also have to incorporate an adjustable bed into their home environment in order to continue to recovery properly. Most beds that are in hospital settings are designed to be as narrow as possible so that the patient can be transferred between departments. Often times, these same beds are the ones that patients receive after going home. However, as mentioned in the background information, bariatric users and patients require a wider bed. This need can cause problems both in the hospital setting and the home care setting.

Regular hospital beds are 80 cm wide. This width is often not enough for obese patients. To remedy this problem, Bispebjerg Hospital has purchased two extra large beds to accommodate these patients (Wiese). However, when the size of the bed increases, the space around the bed in the hospital room decreases. This reduction in space can cause problems for the doctors and nurses who need to attend to the patient.

The hospital will also run into problems if they ever have more than two obese patients at one time requiring an extra wide bed.

The width of an adjustable bed also causes problems for the assistants when they transport the bed and when they handle the bariatric patient in the bed (Clayton). Since adjustable beds for bariatric users and patients are very wide they can pose a problem to the assistants when they try to move the patient while the patient is in the middle of the bed. Bispebjerg Hospital uses sliding sheets for just this reason to help rotate the patient in the bed. However, these sliding sheets are only tested up to 120 kg, thus presenting a problem when dealing with obese patients (Wiese).

When any person is spending a lot of time in a bed it is important to consider the risk of pressure sores. There are several different types of mattresses that are designed to alleviate the occurrence of, and pain associated with pressure sores (Jørgensen). For more temporary situations, extra pillows can also be used between the person and the mattress. However, in most cases, the pillows and mattresses used to alleviate the pain of pressure sores are not wide enough for an obese user or patient (Clayton).

4.1.3 Hoists

Hoists are an integral part of bariatric care. Assistants cannot transfer the patient or user relying simply on their own strength, and often times the patient or user is not independently mobile. Although using a hoist reduces the problem of assistants being injured on the job, they do present their own problems. One problem that occurs when using a mobile hoist to transfer an obese person is that it becomes very hard to push it once the person is in the sling (Clayton). The hoist itself weighs a certain amount, and transferring an obese patient or user adds an extremely large amount of weight to that.

Problems can also occur with the sling that is used as the lifting mechanism. It can often be difficult finding a sling to fit an obese user. Some slings do not provide proper support for an obese person's bulbous gluteal region, causing him or her to sink through the sling (Clayton).

At Bispebjerg Hospital, when using hoists, if the spreader bar is not wide enough it causes the obese patient in the sling to be very uncomfortable (Wiese). The spreader bar that the sling attaches to usually has two arms, one on either side. This feature allows the sling to hang in a semi-seated fashion so that the patient or user can be transferred. However, this design does not take into consideration the extra width that some patients or users may have. Another common problem that Bispebjerg Hospital faces is the limited weight capacity of its hoists. For each department in the hospital there is one mobile hoist that has a weight limit of 150 kg. Throughout the entire hospital there are only two hoists that have a weight capacity of 250 kg each. They must be shared between departments (Wiese). Due to a lack in funding, Bispebjerg Hospital does not have any ceiling mounted hoists, which have higher weight capacities of up to 454 kg. However, now that some ceiling mounted hoists have such high weight capacities, they are limited not by motor lifting capacity, but rather by the load limits of the ceiling mount rigging or post system (Bariatric Ergonomics).

4.1.4 Walking aids

There are many different walking aids available to the disabled population. Each of these walking aids presents its own problems to the obese disabled population. A number of problems occur for obese people when using elbow crutches (Jørgensen and Wiese). The slight angle below the handle creates a weak spot that causes the crutch to break from the excess weight (Wiese). At Bispebjerg Hospital there have been several cases where the crutch will break at this point due to the patient's excess weight. Another problem that occurs with elbow crutches is that the cuffs do not have a large enough diameter to fit around an obese person's arm. This design renders the aid useless.

Since elbow crutches are not practical for obese users, they must find a different type of aid to use. One option would be a rollator. When a rollator is adapted for obese users it is made wider to accommodate for their larger girth and to make it more structurally stable (Jørgensen). The problem that arises from this modification is that the handles are too wide for the obese person to use comfortably. Since the bone structure of obese people does not increase with their weight, as mentioned earlier, their shoulders are the same width as a person that is not obese. The increased width between the handles causes obese users to extend their arms very far apart, and decreases their stability when using a rollator. Since obese people cannot "fit" inside the rollator they are forced to lean forward, which can cause the rollator to "run away" from them. This problem occurs because of the distribution of an obese person's weight. The extra weight obese people carry in front of them causes them to lean slightly forward. When this posture is added to having to lean forward to use the rollator in the first place, and trying to support their extra weight, the rollator becomes an inefficient walking aid for an obese person. This positioning, along with the weight of the user also causes the handles of rollators to break (Wiese).

Another problem with rollators is the amount of space that they require. Most rollators have a basket built into the frame for the convenience of the user. This feature, along with the wheels, increases the amount of space needed to maneuver the rollator.

As mentioned in previous sections, space is one of the main problems for all technical aids that are adapted for obese users and patients.

4.1.5 Commodes

Commodes present many of the same structural problems as wheelchairs due to the similarities in construction. They both need to have a seat that can accommodate the extra width of an obese patient or user, and yet still take into consideration the ability to move the chair through doors and rooms. A common problem that occurs when trying to accommodate the bulbous gluteal region of an obese person is that the seat depth is not great enough to allow for the correct, anatomical positioning needed. (Sørensen, Jørgensen). It is important that the user or patient can sit far enough back in the chair. If their gluteal region is too large in relation to the seat of the chair, they will not be able to properly use the chair, and will be sitting in a very uncomfortable, slouching position (Jørgensen).

Another problem, similar to wheelchairs, is that when the commode is widened for an obese person it becomes too wide to fit through most bathroom doors. Ellen Poulsen, for example, had to move into a special apartment with wider doorframes for her wheelchair and commode when she suffered her stoke. Her husband noted that when the commode chair was in the bathroom, which was relatively small, there was not a lot of extra room to maneuver; this lack of maneuverability is another problem that occurs when the size of the commode chair is increased to accommodate an obese user or patient (Sørensen and Jørgensen). This example creates a circle of problems. To solve the problem of the obese patient or user not being able to fit into the commode chair, it is widened. However, this extra width causes a new problem of not being able to move the chair around or remove it from the bathroom. An important balance must be reached between available bathroom space, and necessary chair width.

There are also mechanical problems that can occur with commode chairs. Often times the bearings used in the wheels are not strong enough to withstand the extra weight. This extra weight can cause maneuverability problems since the bearings will not work as effectively as they may under less pressure. It is also likely that the bearings will break more often, and have to be replaced several times during the usage of the chair (Sørensen).

4.1.6 Other Issues with Equipment

The main problem that Bispebjerg Hospital has when treating obese patients is the size of the equipment that they have available to use (Wiese). The tables used for x-rays are not wide enough for obese patients, and compromises must be made that are not ideal, and may not be as safe for the patient (Wiese). The tables used in operating rooms are also not wide enough to accommodate obese patients. Instead of using the regular operating tables, the patient is often left in his or her hospital bed for the operation. This situation is not ideal since a regular hospital bed does not have the same features as an operating table.

The hospital also runs into problems when trying to move or transfer patients. The stretchers used to transport patients in ambulances cannot exceed a certain width since the back of the ambulance is a fixed size. This restriction has been a problem for the hospital when dealing with obese patients. In one case, a 320 kg patient was placed on an extra wide bed in the back of an ambulance provided by the fire department and transferred to the hospital (Nicolai Wiese).

Municipalities have run into logistical problems with technical aids. Most of the bariatric equipment that is returned to the municipality cannot be reused by another bariatric user (Clayton). This occurrence is an issue because obese people have different body shapes and requirements for technical aids. This difference in body type reduces the probability that a technical aid can be reused by a different person. Other problems that Rødovre Kommune have experienced have to do with the working chairs that disabled people use, for example, in the kitchen when preparing a meal. These working chairs for bariatric users often have an inadequate hydraulic system that cannot handle the extra weight. This problem prevents the user from adjusting the height of the chair while sitting in the chair. The bearings in the wheels are also not strong enough to function under the increased pressure. As with wheelchairs and commode chairs, the armrests tend to break when bariatric users attempt to stand up, or adjust their position while using the armrests for support (Sørensen).

4.2 Problems with Transfer and Handling

Depending on the mobility of the patient or user, the help of an assistant is necessary. To transport patients between buildings and departments at Bispebjerg Hospital, a powered bed "driver" is used so that the assistant does not have to push the bed. However, Bispebjerg Hospital does not own such a driver for a wheelchair. Therefore, when a large patient needs to be transported by wheelchair, two assistants are needed since the weight of the chair itself is 30 kg before adding a patient (Nicolai Wiese). Requiring two assistants to transport an obese patient in a wheelchair means more patient responsibilities for each individual assistant. The hospital also runs into problems moving patients because the doors are not wide enough due to the age of hospital.

There are also ethical problems that arise when assisting bariatric patients. When any patient or user is placed in a sling, the position is unflattering. The patient or user tends to get embarrassed and humiliated when receiving help from an assistant, making them more self-conscious about their weight. Depending on the amount of experience that an assistant has, it is also possible that this situation could be uncomfortable and nerve racking for the assistant (Clayton).

Bispebjerg Hospital's training program for transferring patients does not include instruction on the handling and transferring of obese patients. Each member of the staff goes through training that includes patient transfer techniques, how to use and position one's body correctly, and how to use the technical aids. These training methods are meant to show the assistants how to care for patients without causing injury to them or the patient. However, the program is not specific to the handling of obese patients (Wiese). The training focuses on using the correct type of aid, and ways to eliminate lower back injuries. It emphasizes that a technical aid should not be used if it is not suitable for the weight of the patient. If assistants do not follow the suggested procedure, injuries can occur to both patients and assistants (Wiese). The main precaution that is given when dealing with obese patients is proper transferring techniques. Twenty-eight staff members are injured each year during work at the Bispebjerg Hospital from transferring a patient (Wiese). Nursing professionals fall into the top one-third of occupations that suffer events resulting in non-fatal injuries. Nursing aids are third overall on the same list (Bariatric Ergonomics).

The majority of the accidents and injuries that occur to nurses happen because patients faint or collapse. Nicolai Wiese has consistently received more complaints about low back pain from nurses when they are dealing with obese patients. This increase in complaints means that the training program and techniques are not successful. Nurses do not have the correct technical aids available to them to assist with the moving of an obese patient (Wiese).

5. Conclusions and Recommendations

Through background research and pertinent interviews the unmet needs and problems with technical aids for the obese, and the handling of obese people were identified. A discussion of these issues has led to further research in order to compile possible solutions. This list is by no means a complete one. A mere six interviews were conducted to gather the information presented.

The field of bariatrics is an emerging one, and as mentioned before, is growing. The following section stresses that the field of bariatrics must be identified as a specific kind of patient group that requires unique therapeutic attention. Engineers and healthcare workers must work together in order to identify specific problems, and come up with practical solutions that will not cause further issues for everyone involved.

5.1 Recommendations for Technical Aids

When designing technical aids for any group of patients or users, every situation must be considered. Since there is not a lot of published information regarding bariatrics and the use of technical aids, more considerations must be made. This group of patients present their own problems with healthcare in general and more specifically with technical aids. Each technical aid must be looked at individually in terms of usage and environment. There are different conditions to take into consideration when dealing with a technical aid that is going to be used in a hospital than one that is going to be used in a home. The amount of usage may also change the design and requirements of the aid. All of these factors must be taken into consideration when proposing solutions to the problems discussed above.

5.1.1 Wheelchairs

Immobile bariatric patients and users spend most of their time in wheelchairs since it is their only form of independent movement. Due to the significant amount of time spent in wheelchairs, it is important that they are as practical for users and patients as possible. When designing wheelchairs for bariatric patients and users, a non-foldable chair frame with a firm, padded, ergonomic seat cushion should be used (Jørgensen). These types of chairs, whether manual or powered, will provide the most amount of comfort, support and durability for the patient or user (Jørgensen)

Specifically for manual wheelchairs, the following adaptations should be made: a horizontal bar instead of handles should be implemented to push the wheelchair; an adjustable back rest and seat depth should be integrated; and longer break controls should be installed (Jørgensen). By using a horizontal bar instead of handles to push the wheelchair, the assistants are able to use more of their own strength. The position that the assistant's hands and wrists would be in is also more ergonomically correct (Jørgensen). An adjustable backrest and seat depth will allow the wheelchair to be more customizable thereby better fitting the bariatric person. Due to the extra weight that bariatric people carry, the wheelchair must be adjustable to accommodate the individual body type (Jørgensen). By incorporating longer break controls on all wheelchairs, the users will be able to operate them comfortably by themselves. When people gain extra weight, their bone structure does not change. Since the wheelchair must be made wider to accommodate the extra weight, the wheels are farther away from the center of the chair. This extraneous width prevents the user from easily reaching the breaks attached to the wheels (Jørgensen).

Another comfort issue arises with the position of the user's or patient's legs. By designing footrests that span the entire width of the wheelchair rather than just being off to each side, the person's feet and legs will be in a more anatomically correct position (Wiese). If the footrest were to span the entire width of the wheelchair the users would be able to place their feet wherever is most comfortable. Footrests should also be strengthened because one leg makes up 15% of your body weight. Often times when patients and users try to adjust their sitting position while in the wheelchair, they push on the footrests. Since one leg is 15% of your body weight, an obese person would be putting a significant amount of pressure on the footrest compared to the pressure a lighter weight person would be putting on the same footrest (Wiese).

5.1.2 Adjustable Beds

Every patient in a hospital uses an adjustable hospital bed. Often times, these beds are also needed in the home setting. Just as with wheelchairs, stronger weight capacities on the wheels and bearings of adjustable beds should implemented (Sørensen). Most beds that have been adapted for bariatric users and patients use the same wheels and bearings that normal sized beds use. By using stronger wheels and bearings, the bed will be able to support the extra weight, and assistants will be able maneuver the bed much more easily (Sørensen).

5.1.3 Hoists

The use of a hoist is fundamental in reducing the risk of injury to assistants. Ceiling mounted, or stationary hoists should be used whenever possible when dealing with obese patients and users. It is very hard and potentially dangerous to push an obese person in a mobile hoist (Jørgensen). Ceiling mounted hoists are safer for bariatric patients and users as well as for the assistants that help them (Wiese). Along with the use of ceiling mounted or stationary hoists instead of mobile hoists, the weight capacities on all three of these types of hoists should be increased. The increased weight capacity would allow assistants to utilize these aids for a larger number of patients and users. Incorporating an expandable base into stationary hoists would also allow the aid to be used with more patients and users. The expandable base would allow the hoist to accommodate a bariatric wheelchair, and clear the undercarriage of bariatric beds (Bariatric Ergonomics).

The comfort of a hoist for bariatric patients is also a concern. A typical hoist is equipped with a single sling spreader bar. This type of bar does not allow the sling to hang in such a way to accommodate an obese user. Bispebjerg Hospital has a few hoists that are equipped with bars that have quadra point sling spreader bars (Figure 5.16) instead of single sling spreader bars. These types of bars allow for a point to point diagonal dimension of 63.5 cm so that the sling can hang wider and accommodate the obese patient (Wiese).

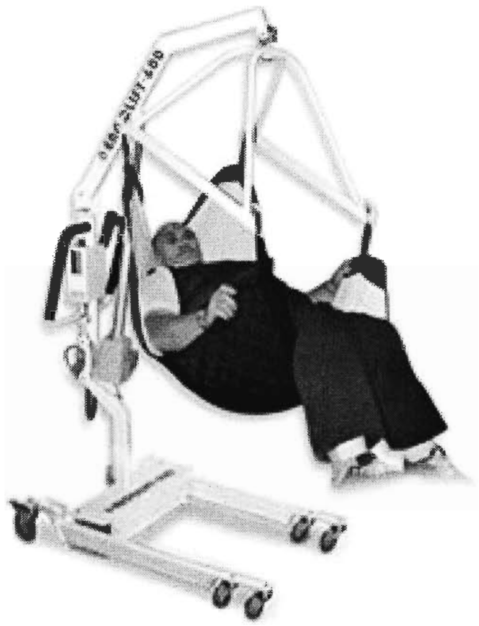

Figure 5.16: Quadra point Spreader Bar

5.1.4 Walking Aids

The more mobile a bariatric user or patient is, the more a walking aid is needed. It is more practical for an obese person to use a walking frame than a rollator. Due to the structure of a walking frame, bariatric users and patients are able to "fit" inside the frame. This frame allows better balance, and takes up less space compared to a rollator (Jørgensen). If the patient or user is more independently stable, the use of crutches may be more suitable. Crutches take up even less room, and are easier to maneuver, allowing the patient or user more freedom. When comparing underarm crutches to elbow crutches, using a regular under the arm crutch would provide obese people with better support and avoid the problems that occur with elbow crutches not fitting around their arms (Jørgensen).

5.1.5 Commodes

As with all of the other technical aids mentioned, commode chairs are essential for bariatric patients and users to function on a day to day basis. These chairs are stationed primarily in the bathroom of the patient or user, which is often the smallest area. Due to the lack of space available, care must be taken when designing commode chairs. When designing a new commode chair, Keld Jørgensen discovered that raising the seat portion of the commode allows excess weight to fold over the edges of the seat. By doing so, the need to increase the width of the entire chair is eliminated. By not widening the chair, it is able to fit in a bathroom without taking up as much space (Jørgensen). The smaller size also allows patients and users to be less dependent on the help of an assistant, thereby reducing the risk of injury to the assistant even more.

5.1.6 Other Recommendations

On the general topic of technical aids for bariatric patients and users, manufactures should design equipment for both apple and pear obese body types (Jørgensen). This consideration will allow technical aids to be used by a wider variety of disabled people, as well as increase the rate of reusability in municipalities. All of the interviewees suggested that all components being used to manufacture these specific technical aids for obese people be strengthened. By increasing the strength of the components the problems with individual components breaking would be eliminated.

5.2 Recommendations for Transfer and Handling

The growing obese population has made the frequency of bariatric patients much higher. This patient increase has caused an increase in the demand for healthcare professionals who are experts in bariatric care (Perkins 2). Unfortunately, there are not nearly enough of these qualified individuals available in the healthcare field.

When designing new hospitals, and renovating existing ones, several things should be taken into consideration. Hospitals should be built with extra wide doorways and specialized bariatric rooms. Extra wide doorways will allow the assistants of bariatric patients to comfortably get in and out of a room with an adjustable bed, wheelchair or mobile hoist (Wiese). Specialized rooms for bariatric patients will also provide convenience for healthcare staff. These rooms should have a considerably larger bathroom and bedroom area compared to a standard room, so bariatric patients and their assistants can perform daily activities with ease. These rooms should be stocked with items that will fit obese patients such as larger blood pressure cuffs and gowns. They should also be furnished with king-sized beds, 91 cm wide wheelchairs, and large shower seats and commodes (Perkins 4).

There are also ethical issues that can arise when treating obese people. The first occurs when weighing them on a scale. The patients often feel embarrassed when they see how much they weigh (Petersen). The second issue arises when placing bariatric patients or users into slings. The design of the sling causes the patient or user to be in an unflattering position. These situations can cause humiliation for the obese person, as well as for the assistant. The best solution is to develop a humorous and easy-going atmosphere. This approach will result in the patients or users being more light-hearted and accepting about their situation (Petersen).

Regarding transportation of bariatric users and patients, there are some modifications that need to be made. For instance, the stretchers used to transport patients in ambulances cannot exceed a certain width since the back of the ambulance is a fixed size.

This limitation has been a problem for Bispebjerg Hospital when dealing with obese patients. In one case, a 320 kg patient was placed on an extra wide bed in the back of an ambulance provided by the fire department and transferred to the hospital (Wiese). There are bariatric stretchers that are available on the American market that can support up to 455 kg, with a width of 102 cm (Med Electronics). Designing the back door of an ambulance to be wider will completely solve the issue of transporting a bariatric patient via ambulance.

Furthermore, there are many changes that can be made in the hospital setting. For example, if the patients are immobile, they must be turned in bed with the help of an assistant. Bispebjerg Hospital has sliding sheets for just this purpose; however, they are only tested up to 120 kg. This testing weight needs be increased since these types of patient movements put the nurse's backs in an unnatural position, which can lead to injury (Wiese). Immobile patients also require the use of a hoist in order to transport them. The wheels that move a mobile hoist tend to be too small, which makes the unit difficult to move. Using larger wheels would make it easier to move around, but they would not be able to fit underneath a bed when it is necessary to lift a patient. A solution to this issue would be to install small motors on the mobile hoists that are difficult to move (Petersen). The products that are the best for assistants to use are those that have greater stability or less portability, and therefore require less skill and are safer (Bariatric Ergonomics).

While searching for additional information regarding the transferring of patients and users, we found a website with a set of algorithms describing the correct way to transfer a patient depending on certain criteria. These algorithms can be found in Appendix D.

5.3 Available Technical Aids on the Danish Market

Using the Danish Centre's database a search of the technical aids focused on in this report for the user weight of 140 kg to 400 kg was performed. Once the search was performed the aids available on the Danish market were checked against the recommendations made in the above chapter. There were some set backs encountered when performing the search in this manner which did not allow for as thorough of an examination as would be preferred. Since the database is in Danish the only way to detect if the technical aids met the recommendations was to look at the pictures the database contained. However, not all the technical aids had pictures available, so not all of the recommendations could be checked against the technical aids. Another problem was that most of the company's web pages were in Danish as well, which further complicated the ability to determine the specific features of the technical aids. If there was more time to conduct this type of examination the companies of the technical aids could have been contacted directly to determine if their technical aids met the recommendations.

There are a few technical aids available on the Danish market that fulfill the recommendations made. One of the recommendations is to use a single footrest that spans the entire width of the wheelchair instead of two footrests, which allows for a more anatomically correct position of the user's hips. There were three companies that incorporate this feature: Kiki Komfortkørestol, Medico Nord, and Invacare. Kiki Komfortkørestol's Power Wheels model has the greatest maximum user weight at 200 kg out of the three companies. Medico Nord's Avant-Garde XXL model and Invacare's Galaxy – Aktivkørestol – Heavy User model both have a maximum user weight of 160 kg. For hoists, one recommendation was to use a quadra point spreader bar to increase the area of the sling. Kebo Care's Molift Heavy Duty hoist incorporates this feature and has a maximum user weight of 300 kg. For crutches it was recommend that obese people use underarm crutches as apposed to elbow crutches. Cobi offers underarm crutches with a maximum user weight of 227 kg. Cobi also offers a commode chair that has a raised seat which helps decrease the total width of the commode chair, and has a weight capacity of 250 kg.

There were some recommendations were made in which there were no available technical aids on the Danish market according to the database used. There were no wheelchairs with a horizontal bar instead of handles to push the wheelchair. There were also no assistive motors for manual wheelchairs and mobile hoists that could handle a user weight greater then 140 kg. Some walking sticks with a user weight less then 140 kg have handgrips that are molded to the hand is recommended to help distribute the weight evenly and comfortably across the user's hand. However, this feature could not be found on walking sticks with a user weight greater then 140 kg. Furthermore, there were no elbow crutches in the Danish Centre's database for the user weight between 140 kg and 400 kg. This problem was encountered while examining the maximum user capacity of all technical aids. There are still very few aids that have a user weight greater then 160 kg. This constriction coincides with one suggestion to use stronger material to increase the maximum user weight of all available technical aids.

There were a number of recommendations that due to the language barrier were not properly investigated. For wheelchairs it was not possible to investigate the availability of adjustable back rests, longer break controls, and stronger material for footrests and armrests. For adjustable beds we were not able to check for stronger weight capacities on wheels and bearings. There was also no way to check if companies designed their technical aids for both apple and pear shaped body types.

Although the examination of the technical aids available on the Danish market was not as thorough as would be preferred, it has still allowed us to determine which of the mentioned recommendations have already been incorporated. The market of technical aids for obese disable people is still an emerging field which, until properly focused upon, will not meet every need of bariatric users or patients.

Glossary of Terms

Adjustable Bed: A bed with one or more sections of the mattress support platform that can be adjusted in height and/or angle. The adjustment can be non-electrically or electrically powered.

Angled Track: A set of different tracks that are angled to allow the hoist to go around corners and bends.

Bariatrics: The branch of medicine that deals with the causes, prevention, and treatment of obesity.

Boom: This feature extends from the mast and provides the horizontal reach. Some booms are angled which increases its ability to lift from the floor, also allowing the person in the hoist head clearance and a 360° of rotation when suspended.

Casters: A pivoting roller attached to the bottom of furniture or trucks or portable machines to make them movable.

Ceiling Hoist: An overhead mounted hoist system fixed to the ceiling or wall(s), including the tracking system.

Cumulative Spinal Loading: The accumulated demands on the spine during the duration of a single-patient-handling activity.

Disability: Any restriction or lack (resulting from impairment) or ability to perform an activity in the range considered normal for a human being.

Disabled Person: Person with one or more impairments, one or more disabilities, one or more handicaps or a combination of impairment, disability and/or handicap.

European Committee for Standardization (CEN): Contributes to the objectives of the European Union and European Economic Area with voluntary technical standards which promote free trade, the safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programs, and public procurement (International Organization for Standardization, Introduction).

Fixed Hoist: A hoist that is permanently installed in living rooms, bathrooms or other locations, and a sling or seat is used to lift and transfer the individual from one location to another.

Free-standing Hoist: A hoist that rests on the floor and uses a sling or a seat to lift and transfer the individual within the mobile range of the unit itself.

Geriatrics: The branch of medical science that deals with diseases and problems specific to the elderly.

Handicap: Disadvantage for a given individual, resulting from an impairment or a disablility, that limits or prevents the fulfilment of a role that is normal (depending on age, sex and social and cultural factors) for that individual.

Hoist: A lifting device for raising disabled patients with the use of a sling.

International Standards Organization (ISO): Acts as an international bridging organization in which a consensus can be reached on solutions that meet both the requirements of business and the broader needs of society, such as the needs of stakeholder groups like consumers and users (European Committee for Standardization, About Us).

Mast: The vertical support, which incorporates the lifting mechanism. Depending on the model this can be with a hydraulic pump, winding handle, or battery powered.

Musculoskeletal Disorder (MSD): Pain, numbness, tingling, aching, stiffness, or burning that has lasted at least one week, or occurred at least monthly in the past year, with a pain intensity of at least 3 (moderate) on a 5 point scale.

Rollators: The same frame as a walking frame, but instead of rubber ferrules these frames have a four-point base with wheels.

Spreader Bar: Located at the end of the boom and provides the width to span the shoulders of a person and the attachment points of hooks for the slings.

Stationary Hoist: A hoist with which a person is lifted, transferred or moved within a pre-defined area and which is fixed to a wall, ceiling or floor or is mounted in or on other allied devices, or is free standing.

Straight Track: A track that carries the hoist in only one direction from one place or room to another

Technical aid: Any product, instrument, equipment or technical system used by a disabled person, especially produced or generally available, preventing, compensating, monitoring, relieving or neutralizing the impairment, disability or handicap.

Turntable: Enables the hoist to negotiate a 90º turn by pushing a button or using a pull cord which releases a mechanism that swivels the hoist 90º.

Walking Aid: Products that help mobility impaired persons move within their environment and give them independence in personal transportation.

Walking Frames: Incorporate the use of four legs, which add stability, to help aid a person walking.

Walking Stick: Aids that have a walking stick style shaft and a three or four point base.

Wheelchair: A device used for mobility by people for whom walking is difficult or impossible, due to an illness or disability.

X-Y Track: Two parallel tracks on each side of a room either on the ceiling or on opposite walls with a moving section of track then runs between the parallel tracks, giving the hoist a complete range of movement.

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Interviews Conducted

30 March 2004 - Karen Clayton, employee of Rødovre Kommune, conducted at the office building of Rødovre Kommune.

30 March 2004 - Henrik Sørensen, manager of the warehouse for Rødovre Kommune, conducted at the warehouse.

30 March 2004 - Ellen Poulsen, disabled obese user in Rødovre Kommune, conducted at her home.

31 March 2004 - Keld Jørgensen, owner of Cobi, a manufacturer and dealer of technical aids, conducted at Cobi.

2 April 2004 - Nicolai Wiese, head of the economics department and in house physical therapy at Bispebjerg Hospital, conducted at his office in the hospital.

27 May 2004 - Mary Petersen, physical therapist for Rødovre Parkvej, conducted at the office building of Rødovre Parkvej.

Appendix A: Interview Questions

Interview questions for Professor Ault

1. What kind of database and/or resources does the Danish Centre have?
2. What kind of work have you done with technical aids?
3. Do you know of any resources that we can consult related to technical aids?
4. What kind of interaction have you had with patient staff?
5. If you had interaction with the staff, what kind of risks did you observe related to patient transfers?
6. Have you dealt with any aspects of ISO or CEN standards in you work with technical aids?

Interview questions for Karen Clayton

1. Could you tell us about Rødovre Kommune and the department of technical aids?
2. How many citizens are in the Rødoure Kommune?
    a. How many of these citizens use technical aids?
    b. What requirements must a citizen fulfill to be lent a technical aid?
3. Do you have any experience with obese users?
    a. If so have you noticed an increase in the number of obese users?
4. What activities are typically problematic for obese users?
    a. What technical aids are typically needed for obese users?
    b. What are some of the typical problems with these technical aids?
    c. What are some of the typical problems that occur in different environments when using these aids (e.g. home, nursing home, hospital)?
    d. Are there any technical aids that have become impractical for obese users?
    e. What adaptations should/could be made to these technical aids?
    f. Are there any ethical problems with obese users that should/could be addressed?
5. What is the typical waiting period to receive a technical aid from application to implementation at Rødovre Kommune?
6. Do you have any accident statistics specific to obese users?
7. Do you know of any other resources or contacts that would help our research?

Interview questions for Keld Jørgensen

1. What is the size of your company in relation to the overall market?
2. What area of technical aids do you focus on in your company?
    a. What technical aids do you manufacture and import?
    b. What are some typical problems that obese people have with the technical aids on the market?
        i. Can you suggest any solutions to these problems?
3. Why you focus mainly on technical aids for obese people?
    a. Do you think that this market is growing?
    b. Do you think that this market is given adequate attention?
4. What problems do you address in designing technical aids for obese people?
5. Have you had any customer complaints towards the operation and/or performance of your technical aids, or technical aids in general?
6. Due to lack of international and European standards, what quality guidelines do you follow for designing technical aids for people over 130 kg?
7. What modifications have you made to existing technical aids in your product line to cater to the needs of an obese person?
    a. Do you think there are any new technical aids that need to be produced that are not currently available on the market?
8. What have you done to your products to accommodate for problems present in the home environment (e.g. loose carpeting, narrow door frames, small bathrooms, etc)?
9. What do you think is the future for your company?

   a. Do you think more attention will be given toward technical aids for the obese?

10. Do you know of any other resources or contacts that would help our research?

Interview questions for Nicolai Wiese

1. What department of the hospital do you work in?
2. What is your job description?
3. How many patients per year are treated at your hospital?
    a. What percentage of these patients are obese?
    b. Have you noticed an increase in the number of obese patients?
4. What are the typical problems you encounter with obese patients regarding safety?
5. What are the major problems concerning obese patients in regards to the hospital environment, technical aids and assistive care?
    a. What are the problems that occur when transferring patients within the hospital?
    b. Do problems occur when transferring patients from an ambulance?
    c. Are there any technical aids that have become impractical for obese patients?
    d. What adaptations should or could be made to these technical aids?
    e. Are there any ethical problems with obese users that should be addressed?
6. Do you have accident statistics concerning assistants that we could look at?
7. What kind of training procedures does the staff go through for the handling of patients?
    a. Does this training cover the handling of obese patients?
    b. What specific precautions are given and taken when handling obese patients?

c. What are the types of problems and injuries that the training procedures focus on?

8. Do you see an increase in the risk to the assistants as the weight of the patient increases?
9. Are there any modifications to the equipment, hospital, and/or training procedure that you can suggest?
10. Do you know of any other resources or contacts that would help our research?

Interview Questions for Mary Pederson

1. Could you tell us about Rødovre Parkvej and your experience with technical aids?
    a. How many employees?
2. Do you have any experience with obese users?
    b. If so have you noticed an increase in the number of obese users?
3. What activities are typically problematic for obese users?
    c. What technical aids are typically needed for obese users?
    d. What are some of the typical problems with these technical aids?
    e. What are some of the typical problems that occur in different environments when using these aids (e.g. home, nursing home, hospital)?
    f. Are there any technical aids that have become impractical for obese users?
    g. What adaptations should/could be made to these technical aids?
    h. Are there any ethical problems with obese users that should/could be addressed?
4. What are the typical problems that you have noticed with the handling/transfer of obese patients?
    i. Can you recommend any solutions to these problems?
5. From your experience as a physical therapist have you come across and information that specifically focuses on obese patients?

Appendix B: Synopsis's of Interviews

Synopsis of interview at Rødovre Kommune – Karen Clayton

The Rødovre Kommune, in Rødovre, Denmark, distributes technical aids to citizens in need. The municipality is a part of the social department of Rødovre, and they have a staff of 18 people. Of the 37,000 citizens of Rødovre, 2,500 to 3,000 citizens are disabled and require technical assistance. In order to be lent a technical aid, the person must have a lasting disability that would force them to be dependent on a technical aid daily. They have little experience with obese people who require technical aids, but they claim that the number of bariatric users increases every year.

There are many problems with bariatric users and patients, and the equipment they use. The most typical day to day problems that disabled obese people encounter are walking, bathing, getting in and out of bed, getting through doorways, and not having adequate space in the rooms of a home (e.g. bathroom). In Rødovre, for example, a lot of the flats are too small for most bariatric users to comfortably maneuver around their home. Technical aids that are commonly used to solve most of these problems are rollators, walking frames, walking sticks, commodes, manual and powered wheelchairs, hoists, and kitchen working chairs. The most common problem with these aids is that the components break due to low weight capacities. For example, the armrests and wheels on most of the bariatric wheelchairs are suited for standard size wheelchairs, which means that there are designers that are not accounting for safety and durability issues. Also, most of the bariatric equipment that is returned to the municipality cannot be reused by another bariatric user. This occurrence is because obese people have different body shapes and requirements for a technical aid, so the probability that a technical aid can be reused is very small. Moreover, a public handicap bus cannot transport many wheelchairs because the buses cannot lift a wheelchair that has a width greater than 63 cm (43 cm seat width). This restriction means that if a bariatric user requires a seat width greater than 43 cm they are denied public transportation. Furthermore, manual wheelchairs are predominantly impractical because a bariatric user has a small amount of leverage when propelling the wheels. This lack of leverage is because an obese person's bone structure is out of proportion with their body size, so they must reach a further distance to the wheel compared to a proportionally sized person. Walking frames and sticks are also impractical due to the lack of strength. Lastly, hoists tend to be a problem when transporting patients because their excess fat slips through the sling supports. The biggest and most important modification that can be made to bariatric equipment is to increase the strength of the components.

There are also ethical problems that arise when assisting bariatric patients. They tend to get embarrassed and humiliated when receiving help from an assistant. A solution to this problem is to have experienced adults work with bariatric patients and to also house the patient in a single room without another patient, so they feel as comfortable as possible.

The typical waiting period for a technical aid is 1 to 2 weeks. If a technical aid needs to be custom made for a bariatric user then the waiting period could last as long as 3 months. There is no waiting period between the application for the technical aid and sending it out, if the aid is in stock in the warehouse.

Synopsis of Interview at Rødovre Kommune's Warehouse – Henrik Sørensen

Many technical aids in the warehouse are constructed with low quality components and have technical issues that need to be addressed. The manual wheelchairs do not have adjustable backrests, and the armrests break due to low weight specifications. The working chairs for bariatric users have an inadequate hydraulic system, the bearings are not strong enough, and the armrests break. The commodes' wheels and bearings are not strong enough and tend to break as well. The powered wheelchairs' motors break down quickly because the motor is suited for a lighter person, so there is excessive strain on the motor. The adjustable beds are very wide and can pose a problem to the assistants when they try to move the patient while the patient is in the middle of the bed. Also, the pillows used to alleviate the pain of pressure sores are not wide enough.

Synopsis of interview at Bariatric User's Home – Ellen Poulsen

Ellen Poulsen had a stroke about 5 years ago that made her dependent on a powered wheelchair. The reason she did not use a manual wheelchair was because half her body was paralyzed from the stroke, and it caused her pain to move the wheelchair herself. Her former home did not have an elevator and the doors were not wide enough to accommodate her wheelchair, so she was forced to move to a nursing home until she found a specialized apartment with an elevator in the apartment building. Her new apartment has extra wide doors, no carpeting on the floors, a ceiling mounted hoist, an adjustable bed with a turning sheet, and a bathroom equipped with a commode chair and a handicapped toilet. The sling she uses when being hoisted fits fine now, but required a couple size changes to find the right size. The bathroom is sufficient but could be a little bigger for easier maneuvering.

Synopsis of interview at Cobi – Keld Jørgensen

There are 30 companies in Denmark that specialize in technical aids, 10 of which are middle-sized companies and 15 are smaller in size. Out of the 30 companies there are three or four major companies that manufacture and/or import technical aids. Cobi is a small company, made up of four individuals, that manufactures and imports technical aids. They concentrate on mattresses for prevention and treatment of bedsores along with technical aids for bariatric people. They manufacture a commode chair for obese people and import mattresses (air and foam), wheelchairs (manual and powered), walkers, and crutches (elbow and under arm). They sell 99% of their technical aids to the municipalities and only 1% to individuals. When asked why Cobi focuses on technical aids for obese people Keld Jørgensen, owner of Cobi, responded that he saw the potential in the market because there has not been a lot of focus on it and right now it is a relatively small market, and because they are a small company they want to go after the smaller markets. Keld feels that the market of technical aids for obese people is much larger then people realize and it is not getting the proper attention.

Some of the typical problems obese people face is that they do not have good balance due to their weight distribution in their stomach and lower hip region. They also experience pain in their hips and knees. One of the most common problems they face with technical aids on the market is that they do not fit. The products that are made to handle the larger weight capacity are usually "normal" aids that are modified to be bigger and stronger. The problem that occurs with these modifications is that it does not solve all of the physical problems with the technical aids. In the case of a wheelchair the overall width is to great to fit through most common doorways in the home, hospital, busses, trains, etc.; the bearings on the wheels can't support the extra weight; the armrest and footrest can't support the extra weight; and the seat depth isn't great enough to accommodate a bulbose gluteal region, which is also a problem for the commode seat. Another problem that occurs with the manual wheelchairs is that the obese person has a very difficult time moving the wheelchair. Since the bone structure of an obese person does not increase with their weight, when using a wheelchair they have to get their arms around their fat in order to move the wheels. This position causes them to lose a significant range of motion, only allowing them very small pushes of the wheels. A problem that has occurred from the use of foldable wheelchairs is that the obese person sinks into the seat, which is soft and unsupported, causing it to cave in. This "caving in" effect puts a lot of pressure on their hips, which is very uncomfortable. A problem that occurs when using a mobile hoist to transfer an obese person is that it is extremely hard to push the mobile hoist once the person is in the sling. Another problem that occurs with the use of a hoist is finding a sling that can fit the obese patient or user. In the case of some slings that do not provide proper support for the obese person's bulbose gluteal region, once in the sling they can fall through because their fat slides up and they slide down. Since obese people have very bad balance, walking aids in general are difficult for them to use. The problems that occur with elbow crutches are that the cuffs that hold the arm are not big enough, and the structure itself is not strong enough to support the weight. When the rollator is adapted for an obese person, it is made wider which can lead to a very awkward position. Since the obese person cannot "fit" inside the rollator they are force to lean forward. Due to the extra weight they have in front of them this added leaning forward can lead to the rollator running away from them.

Keld Jørgensen offered his opinion on possible solutions to these common problems with technical aids for obese people. He said that there are two different body types, apple and pair shape, so when technical aids are designed for obese people these two body types should be taken into consideration. Some suggestions Jørgensen gave for manual wheelchairs were to use a horizontal bar instead of handles to push the wheelchair; to adapt an adjustable back rest and seat depth; and to incorporate longer break controls. Since it is very hard to push an obese patient in a mobile hoist, he suggested that ceiling mounted or stationary hoists be used instead. He suggested that it would be better for an obese person to use a walking frame instead of a rollator because they can "fit" inside the walking frame, which allows them better balance. He felt that using a regular under the arm crutch would provide an obese person with better support and avoid the problems that occur with elbow crutches not fitting their arms.

Synopysis of interview at Bispebjerg Hospital – Nicolai Wiese

Nicolai Wiese has been the head of the economics department at Bispebjerg Hospital since 1998. He also organizes trainings for staff (4000 total) on handling techniques and the use of technical aids. There are 800 beds available at the hospital with 13,000 patients and 80,000 outpatients a year. Approximately 15-20% of these patients are overweight, and 6-7% are obese. In the past 2 years, Nicolai has come in contact with 12 patients that have been over 150 kg. In 2000 the hospital treated its first severely obese patient, and has since treated approximately 20 more obese patients.

The main problems that the hospital has when treating obese patients is the size of the equipment they need to use. The tables used in operating rooms are not wide enough to accommodate the obese patients. Instead of using the regular operating tables, the patient is often left in their hospital bed for the operation. The tables used for x-rays are also not wide enough, and often two tables must be used, or the x-ray system must be brought to the patient. Regular hospital beds are 80 cm wide, which is often not wide enough for obese patients, so the hospital has purchased two extra large beds to accommodate for these patients. However, when the size of the bed increases, the space around the bed in the hospital room decreases. Often times, the hospital will place an obese patient in a room by themselves where there would normally be two beds. This accommodation allows for more room so that the nurses and doctors can attend to the patient.

The hospital also runs into problems when trying to move or transfer patients. The stretchers used to transport patients in ambulances cannot exceed a certain width since the back of the ambulance is a fixed size. This limitation has been a problem for the hospital when dealing with obese patients. In one case, a 320 kg patient was placed on an extra wide bed in the back of an ambulance provided by the fire department and transferred to the hospital. The wheelchairs that are usually used are not wide enough, and if they are collapsible the seat is often not strong enough to support the extra weight. To protect against the wheelchair collapsing beneath the patient, the hospital has several non-collapsible wheelchairs that also have a wider seat width and depth. Nicolai also pointed out that there is a problem with the width and strength of the footrests of wheelchairs. When the seat of the wheelchair is made wider, the footrests are placed farther apart. This feature can be a problem for obese patients' hips and legs since their bone structure did not change when they gained weight. Nicolai suggested that footrests span the width of the entire wheelchair rather than just being off to each side so that it is more anatomically practical. He also suggests that the footrests be strengthened since one of your legs makes up 15% of your body weight. To transport patients between buildings and departments, a powered bed "driver" is used so that the assistant does not have to push the bed. However, there is no such driver for a wheelchair. Therefore, when a large patient needs to be transported by wheelchair, two assistants are needed since the weight of the chair itself is 30 kg. When transferring a patient from a bed to a wheelchair, or vice versa, using a ceiling mounted hoist, the bar may not be wide enough to make the transfer comfortable for the patient. The hospital has a few hoists that are equipped with bars that have four arms instead of two so that the sling can hang wider and accommodate an obese patient. The weight limit of the hoist has also caused problems. For each department in the hospital there is one mobile hoist that has a weight limit of 150 kg. Throughout the entire hospital there are two hoists that have a weight limit of 250 kg each that must be shared between departments.

Other problems can occur depending on the mobility of the patient. If the patient is immobile, they must be turned in bed with the help of an assistant. The hospital has sliding sheets for just this purpose, but they are only tested up 120 kg. Nicolai suggested that this testing weight be increased since this type of patient movement is very tough on nurses' backs. If the patient is able to move around on their own with only the help of a walking aid, strength problems can occur as well. Elbow crutches and rollators are often not strong enough because of their construction. The slight angle in the elbow crutches creates a weak spot. The hospital has had several cases where the crutch will break at this point due to the patient weighing too much. The same problem is encountered when using rollators since the patient is putting all of their weight on the handles that are not supported enough for increased weight. Obese patients also have a problem with the forearm cuff of the elbow crutches. These cuffs are often too tight to fit around the patient's arm, and the crutches cannot be used.

Each member of the staff goes through training that includes patient transfer techniques, how to use and position your body correctly, and how to use the technical aids. The program is not specific to the handling of obese patients, however, there is a brochure that is provided about dealing with obese patients, and Nicolai is available via email or in person for extra information and support. The main precaution that is given when dealing with obese patients is proper transferring techniques. Twenty-eight staff members are injured each year during work at the hospital from transferring a patient. The training focuses on using the correct type of aid, and ways to eliminate lower back injuries. It emphasizes that a technical aid should not be used if it is not suitable for the weight of the patient.

The majority of the accidents and injuries that occur to nurses happen because a patient faints or collapses. Nicolai has consistently received more complaints about low back pain from nurses when they are dealing with obese patients. The hospital has a program for staff members who have been injured on the job so that they can receive physical therapy during work for that injury. Nicolai gave us an accident report from 2002 and the first quarter of 2003 that shows how many staff members obtained injuries, and how many days of work they missed in each major department of the hospital.

When asked if there were any other modifications to the equipment, hospital and/or training programs that he could suggest, Nicolai pointed out that the hospital building is old, and the doorways are not wide enough. Of course nothing can be done about this problem now, but when future hospitals are built, architects should take into consideration the width of beds and equipment that will be used.

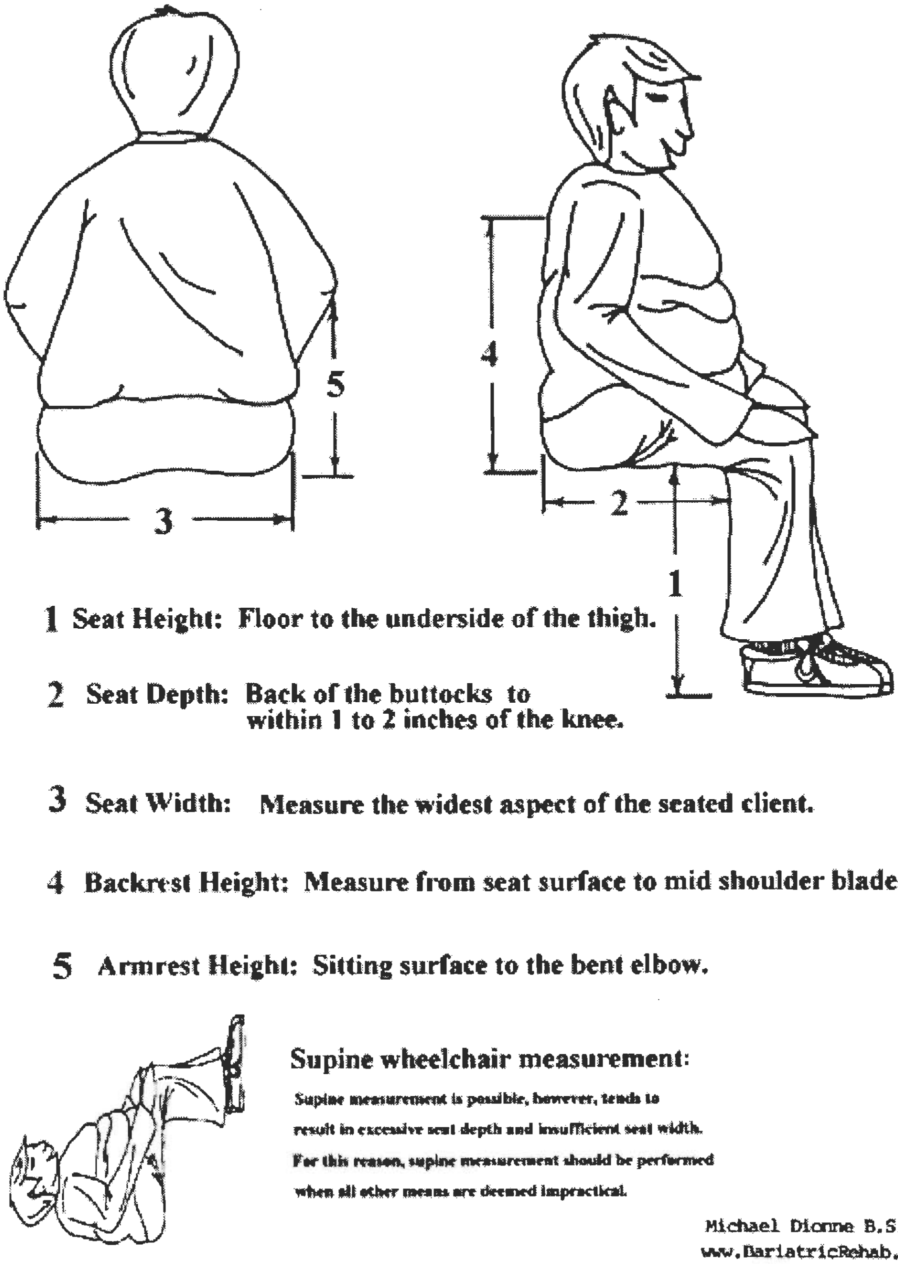
Synopysis of interview at Rødovre Parkvej – Mary Petersen

Rødovre Parkvej is a consulting organization in Rødovre, Denmark. They give advice about disabled people and technical aids to 18 local municipalities, who are organizations that actually lend out the technical aids to citizens. They also give advice to the citizens in their area (600,000 people) about technical aids and the laws that are involved in receiving an aid. Rødovre Parkvej has 9 employees including 4 therapists, 1 leader, 2 office assistants, and 2 technicians. We interviewed one of the physical therapists, Mary Petersen, who has experience in customizing technical aids for bariatric users. She weighs patients and measures body dimensions in order to successfully customize a technical aid.

She mentioned a number of problems with technical aids that are on the market today. First, she noted that there is an increase in the number of bariatric users, and that the rate of increase is getting larger every year. Regarding wheelchairs, the rear wheels tend to be made of a soft rubber that causes a large amount of friction with the surface when traveling. She recommended using a harder, denser rubber instead, which would result in less friction with the surface. The disadvantage of using a harder material is that the shock absorption of the wheelchair will be less, and the overall comfort factor of the wheelchair will decrease. Also, shoulder injuries often result in bariatric users who operate a manual wheelchair. These injuries are partly due to the unnatural positioning of the shoulder joints when propelling the wheels; another factor is the large amount of force that is required to move at an adequate pace in a manual wheelchair. Moreover, walking sticks are often unacceptable to prescribe to a bariatric user. This is because the handle not only puts an excessive amount of pressure on the user's wrist and arm, but the handle is not strong enough and cannot support the weight demands. A solution is to use an underarm crutch, which distributes most of the weight on the torso of the user instead of the wrist and arm. If used properly, the underarm crutch is more comfortable than the walking stick. Furthermore, the wheels that move a mobile hoist tend to be too small, which makes the unit difficult to move. Using larger wheels would make it easier to move around, but they cannot fit underneath a bed when it is necessary to lift a patient. A solution to this issue is installing small motors on mobile hoists that are difficult to move.

There are also some issues involved when giving bariatric users physical therapy. First, Mary said there is a problem with determining what the width of a wheelchair should be for a bariatric user when customizing. Essentially, selecting the appropriate width of a chair is based on where the user's pelvic bones are. The problem lies in accurately finding the location of the pelvic bones because of all the excess fat around that area. Another therapy related issue is the unnatural positioning of a bariatric user's legs. Due to the excessive amount of fat on the inside of an obese person's legs, their legs are naturally more spread out when in the sedentary position. This unnatural position is not conducive to a healthy pelvic area. Lastly, an ethical issue that occurs when giving obese people physical therapy is weighing them on a scale. Mary said the patients feel embarrassed when they see how much they weigh. The best solution is to develop a humorous and easy-going atmosphere. This approach will result in the patients being more light-hearted and accepting about their situation.

Appendix C: Wheelchair Prescription



A special note regarding the difference between Bariatric and standard wheelchairs. The center of body mass is located somewhere about 1 inch forward of the second sacral vertebrae in the average person. Wheelchair manufactures know that having ~ 80% of *body weight over the rear axle maximizes ease of wheelchair propulsion by unweighting the front caster wheels. In the Baratric client this center of body mass may be several inches forward when compared to the client of average weight. For this reason, the specialized bariatric wheelchair has a rear axle displaced further forward relative to the standard wheelchair just to achieve the same ~ 80% body weight over the rear axle. Orthopedically this forward axle also allows mechanical advantage for the bariatric client to propel by means of a full arm push and not wrist extension seen in wheelchair prescription where the axle is too far behind the patient's shoulder.*

Wheelchair Prescription:

Actual body weight. If clients body type is "pear like" consider potential of stable weight and stable w/c width indication over time. If client body type is "apple like" consider potential for fluctuating weight. If deciding between two sizes consider opting for the larger size and potentially wider w/c. The final wheelchair design selected should, of course, meet the dynamic load potential of the intended client.

Measuring:

When measuring this client population, if possible have the client sit on a hard surface such as a therapy mat, original wheelchair, or on a square of firm plywood. The client's thighs should be level and not upward or downward sloping relative to the hip joint. The lower leg should be in a comfortable vertically oriented posture. This posture allows for easy access to measure the client from a true postural set, otherwise not possible from a soft surface. Once the overall height is determined, the next consideration in W/C prescription is measurement of the pelvic region. This is the client's primary weight bearing surface. W/C measurement is possible while the client is lying in bed, however, very subject to error as adipose tissue sags posteriorly rather then inferiorly as observed in sitting postures. The supine measurement therefore contributes to undersized width and excessive depth as the clients legs do not abduct as in the sitting posture where abdominal contents drift inferiorly between the clients legs.

1. Seat Height:

With feet flat on the floor and the shin in vertical posture, measure from the back of the heel to underside of knee. The client should wear typical footwear and again the thighs should be level relative to the hip joint prior to measurement. This will allow for proper foot rest length and overall W/C height which is so vital in W/C propulsion for those who tend to achieve propulsion by combination of hand and foot use. W/C floor to seat height is also critical for sit to stand activities. For individuals who are primarily exercise ambulators, a lower seat height may be indicated allowing community propulsion while for individuals who ambulate (functional ambulators) to vital rooms or bathrooms, a higher seat height may be indicated. Recall that W/C cushions will add to the height of the finished sitting surface. Extra low or bariatric hemi-wheelchairs are also available providing sufficient mechanical advantage for those who rely upon one sided (unilateral) W/C propulsion or bipedal W/C propulsion.

2. Seat Depth:

Measure from the back of the buttocks to within ~ 1 to 2 inches of the back of knee. The completed W/C should allow for approximately 1 to 2 inches of space between the back of the clients knee and the front of the W/C seat, thereby preserving circulation to the lower leg while maximizing the clients weight bearing surface and leg mobility during foot assisted propulsion. The seat surface should support the entire gluteal region.

If a client has a posteriorly bulbous gluteal region, then a contoured cushion or strap backrest may help provide sufficient trunk support.

3. Seat Width:

Measure widest part of client in the seated posture. Again consider apple versus pear. A pear shaped individual having greater gluteal femoral weight distribution may be widest near the front edge of the seat. Excessive W/C width will restrict mobility about environmental barriers, increase difficulty of both turning and forward propulsion while decreasing armrest support with resulting potential for back pain. The completed W/C will allow for approximately 1 to 2 inches of width on either side of the client for winter clothing, client weight shifting during pressure relief, and if necessary room for possible lift devices such as slings. On occasion clients may opt to remove W/C push rims to accommodate narrow doorways or environmental barriers.

4. Backrest Height:

Measure from the seat surface to mid shoulder blade height.

The back rest generally should reach to mid shoulder blade level in height and support the apex of the client's back to diminish potential for postural back pain thus providing for adequate pressure relief while allowing maximal shoulder blade mobility. If the client is in a reclining chair then additional upper thoracic support may be indicated. More agile clients may prefer a backrest that is positioned vertically just ~ 1 inch below the shoulder blade allowing for maximal upper body mobility over their lower trunk. in sitting postures. If a the client should have localized excessive tissue bulk causing partial contact to their backrest. A strap or laced back backrest may be indicated to provide sufficient support for that unique body type.

5. Armrest Height:

Measure directly from the sitting surface to the bent elbow having the forearm parallel to the seat. Recall that a seat cushion may add the height of the seat and equally add to the height of the armrest. Appropriate armrest height is determined from this measurement and is important for decreasing neck and thoracic back pain by providing adequate support for the shoulder girdle. Remember that respiratory impaired individuals derive increased respiratory support by leaning upon their forearms and thereby increase depth of breathing by reverse action of upper body muscles. This is common in the obese client with respiratory compromise or congestive heart failure. Pressure relief, weight shifting and sit to stand activities may also be augmented by armrest height in some individuals.

Hard Seat Applications:

Solid hard seat applications provide superior weight bearing distribution and overall superior orthopedic alignment. To the client, this is experienced in decreased muscular pain related to prolonged poor postures. The hard seat application tends to be more durable making them ideal for clients who rely upon their W/C as a primary source of mobility. The difficulty in providing hard seat applications are financial and client familiarity with side folding W/C's.

Specific medical indications which require hard seat applications include:

- presence of neurologic disease with spasticity,
- post stroke or other forms of paralysis and
- severe orthopedic deformity.

Tires:

Consider that hard solid tires have increased durability especially in turning. Pneumatic tires provide a smoother ride and return greater energy to the user, but have a tendency to roll off the rim during turning and may experience premature sidewall tire fatigue over time. Further, pneumatic tires and spoked rims require continued maintenance not necessary in the mag wheel solid tire application. Pneumatic tires also can sustain leaks resulting in flats, therefore tend to be used for the client who requires performance.

Adjustable Backrest Indications:

In the past, Velcro strapping within W/C back rest has been used to accommodate client orthopedic and neurologic deformity, creating a custom fit pressure-relief surface. For the bariatric client, strapped or laced backrest have evolved independently, allowing posterior translation of seat depth, thereby placing the client's center of gravity over the rear axle for effective propulsion. Such adjustable backrest also allow adjustment to accommodate excessive posteriorly displaced tissue bulk often seen in the client with a bulbous gluteal region.

Reclining W/C Applications:

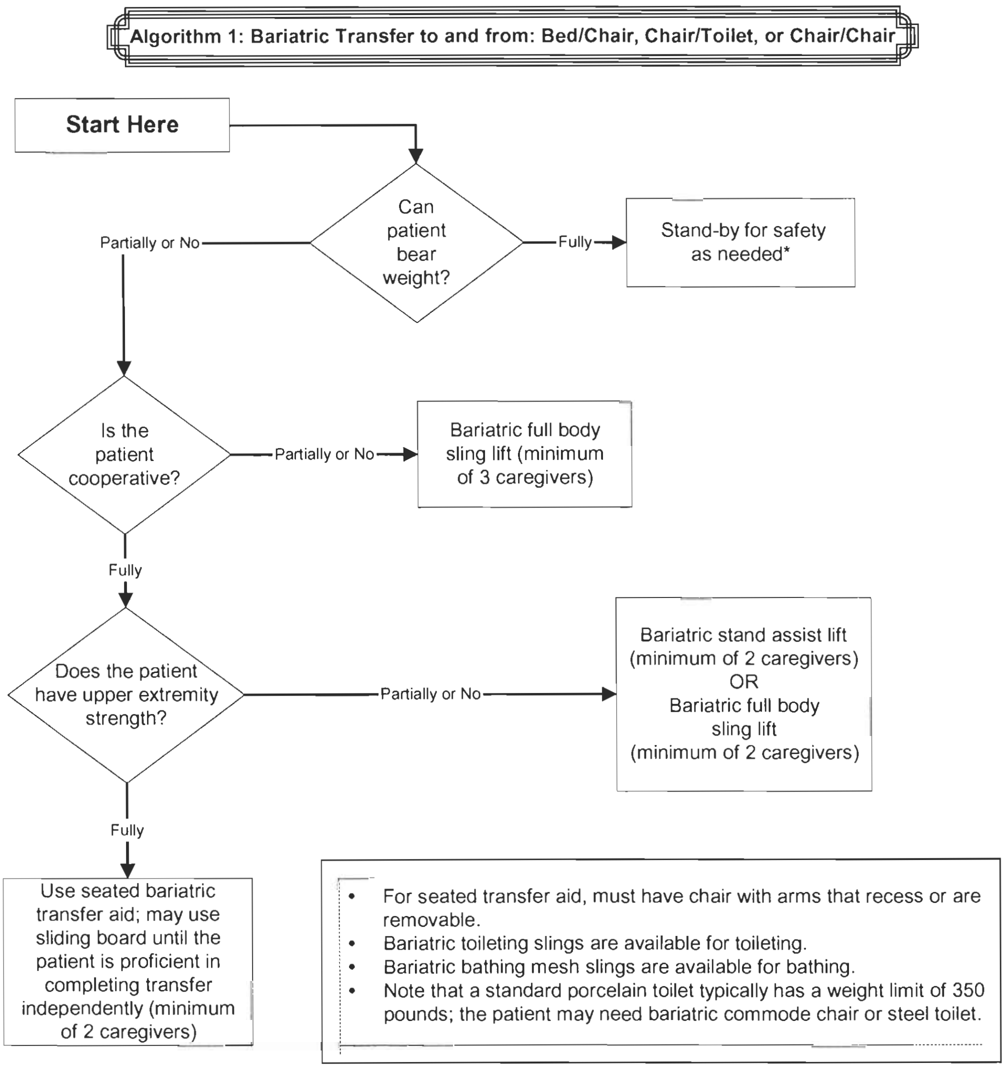
Clients unable to sit vertically because of excessive abdominal tissue bulk limiting hip flexion range of motion, or excessive tissue contributing to respiratory resistance in upright sitting postures may require a reclined backrest application. Other medical conditions restricting individuals from upright postures include orthostatic hypotension, psychological influences and fear often more apparent during initial phases of rehabilitation.

Power W/C Applications:

Recommendations include: Order designed heavy duty wheelchairs rather then attempting to upgrade standard power w/c applications. Lessor applications are susceptible to metal fatigue upon impact and shear forces often at caster mounts, caster wheel axles, foot plate mounts, and general frame integrity. Motor durability issues should also be obvious. Many individuals require power applications due to cardiac insufficiency. Some third party payers will reimburse for power W/C's if prescription will dramatically increase client participation in community activities such as employment while decreasing the clients dependency upon medical services.

Appendix D: Bariatric Transfer Algorithms

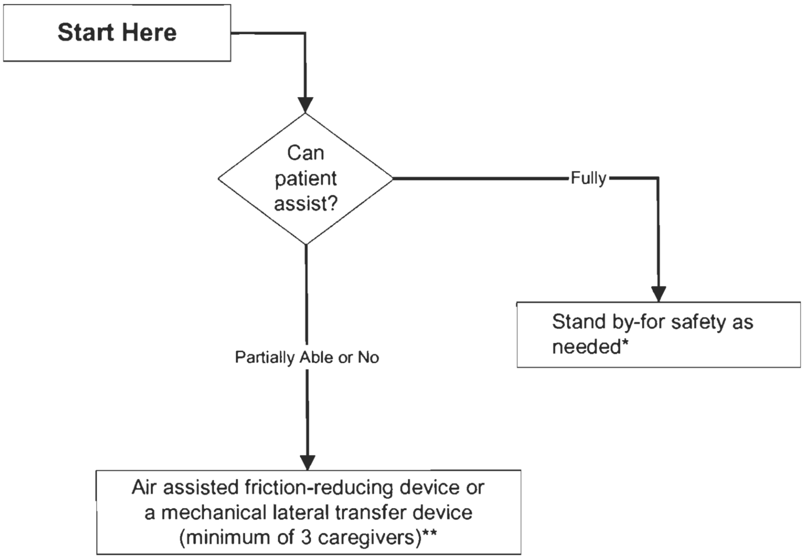
www.patientsafetycenter.com/TechResGuide/summary-02new.htm



* "Stand-by for safety." In most cases, if a bariatric patient is about to fall, there is very little that the caregiver can do to prevent the fall. The caregiver should be prepared to move any items out of the way that could cause injury, try to protect the patient's head from striking any objects or the floor and seek assistance as needed once the person has fallen.

- If patient has partial weight-bearing capability, transfer toward stronger side.
- Consider using an abdominal binder if the patient's abdomen impairs a patient handling task.
- Assure equipment used meets weight requirements. Standard equipment is generally limited to 250-350 lbs. Facilities should apply a sticker to all bariatric equipment with "EC"(for expanded capabity) and a space for the manufacturer's rated weight capabity for that particular equipment model.
- Identify a leader when performing tasks with multiple caregivers. This will assure that the task is synchronized for increased safety of the healthcare provider and the patient.

Algorithm 2: Bariatric Lateral Transfer to and from: Bed/Stretcher, Trolley



- Lower the destination surface should be about 1/2" for all lateral patient moves.
- Avoid shearing force.
- Make sure bed is the right width, so excessive reaching by caregiver is not required.
- Lateral transfers should not be used with speciality beds that interfere with the transfer. In this case, use a full body sling lift.
- Use a bariatric stretcher or trolley if patient exceeds weight capacity of traditional equipment.**

* "Stand-by for safety." In most cases, if a bariatric patient is about to fall, there is very little that the caregiver can do to prevent the fall. The caregiver should be prepared to move any items out of the way that could cause injury, try to protect the patient's head from striking any objects or the floor and seek assistance as needed once the person has fallen.

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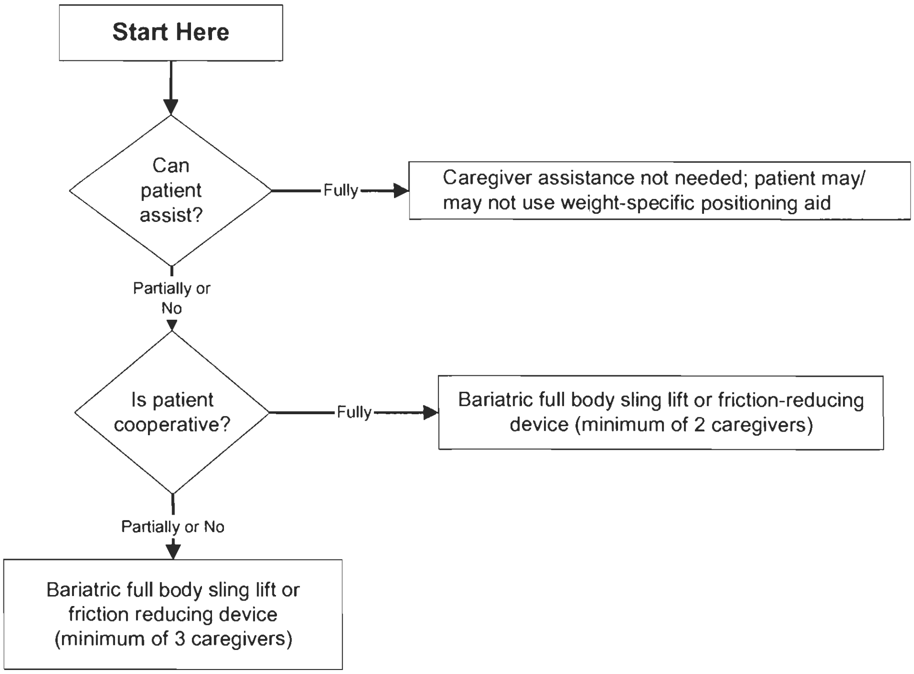
- Identify a leader when performing tasks with multiple caregivers. This will assure that the task is synchronized for increased safety of the healthcare provider and the patient.

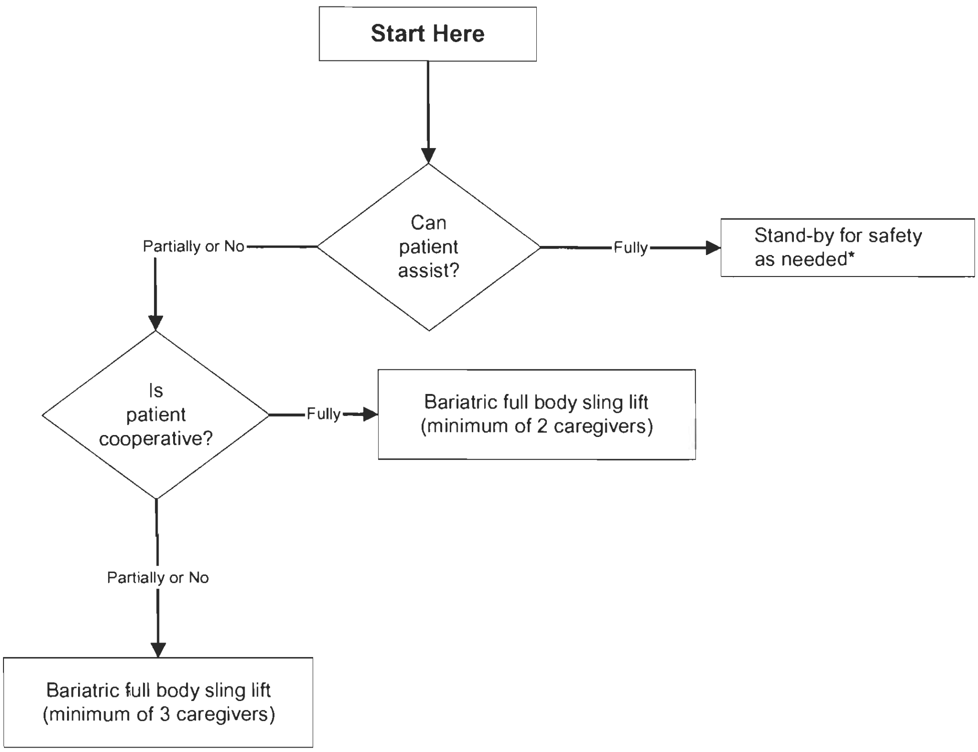
Algorithm 3: Bariatric Reposition in Bed: Side-to-Side, Up in Bed



- When pulling a patient up in bed, place the bed flat or in a Trendelenburg position (if tolerated and not medically contraindicated) to aid in gravity; the side rail should be down.
- Avoid shearing force.
- Adjust the height of the bed to elbow height.
- Mobilize the patient as early as possible to avoid weakness resulting from bed rest. This will promote patient independence and reduce the number of high risk tasks caregivers will provide.
- Consider leaving a friction-reducing device covered with drawsheet, under patient at all times to minimize risk to staff during transfers as long as it doesn't negate the pressure relief qualities of the mattress/overlay.
- Use a sealed, high-density, foam wedge to firmy reposition patient on side. Skid-resistant texture materials vary and come in set shapes and cut-your-own rolls. Examples include:
  - Dycem (TM)
  - Scoot-Guard (TM): antimicrobial; clean with soap and water, air dry.
  - Posey-Grip (TM): Posey Grip does not hold when wet. Washable, reusable, air dry.

- If patient has partial weight-bearing capability, transfer toward stronger side.
- Consider using an abdominal binder if the patient's abdomen impairs a patient handling task.
- Assure equipment used meets weight requirements. Standard equipment is generally limited to 250-350 lbs. Facilities should apply a sticker to all bariatric equipment with "EC"(for expanded capabity) and a space for the manufacturer's
  rated weight capabity for that particular equipment model.
- Identify a leader when performing tasks with multiple caregivers. This will assure that the task is synchronized for increased safety of the healthcare provider and the patient.

Algorithm 4: Bariatric Reposition in Chair: Wheelchair, Chair, or Dependency Chair

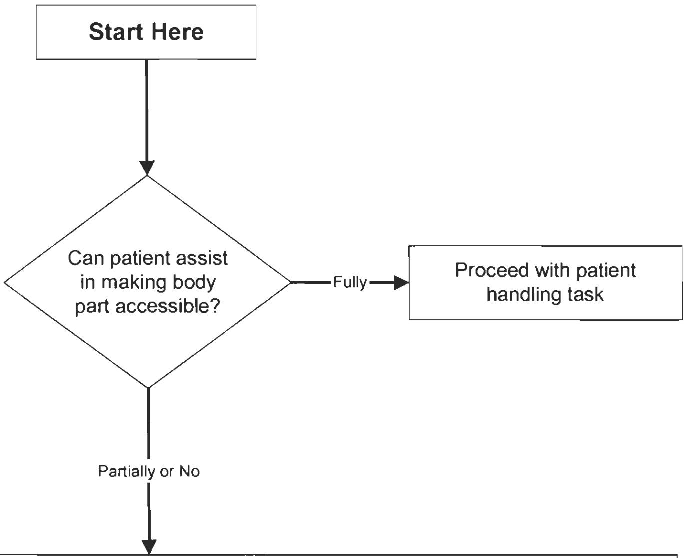


- Take full advantage of chair functions, e.g., chair that reclines, or use or arm rest of chair to facilitate repositioning.
- Make sure the chair wheels are locked.
- Consider leaving the sling under the patient at all times to minimize risk to staff during transfers after carefully considering skin risk to patient and the risk of removing/replacing the sling for subsequent moves.

* "Stand-by for safety." In most cases, if a bariatric patient is about to fall, there is very little that the caregiver can do to prevent the fall. The caregiver should be prepared to move any items out of the way that could cause injury, try to protect the patient's head from striking any objects or the floor and seek assistance as needed once the person has fallen.

- If patient has partial weight-bearing capability, transfer toward stronger side.
- Consider using an abdominal binder if the patient's abdomen impairs a patient handling task.
- Assure equipment used meets weight requirements. Standard equipment is generally limited to 250-350 lbs. Facilities should apply a sticker to all bariatric equipment with "EC"(for expanded capabity) and a space for the manufacturer's rated weight capabity for that particular equipment model.
- Identify a leader when performing tasks with multiple caregivers. This will assure that the task is synchronized for increased safety of the healthcare provider and the patient.

Algorithm 5: Patient Handling Tasks Requiring Sustained Holding of a Limb or Access to Body Parts



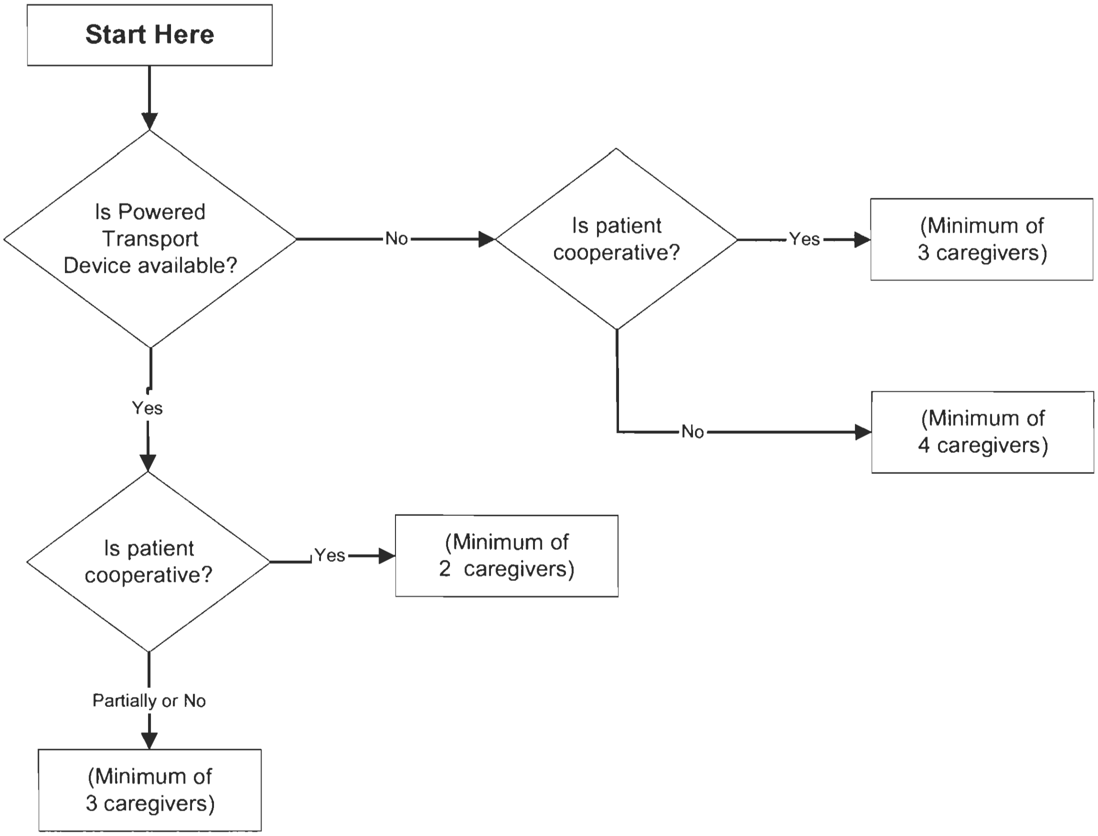
Assemble multidisciplinary team to develop creative solutions that are safe for patient and caregiver.

Examples:

- Modify use of a full body sling lift to elevate limbs for bathing or wound care.
- Use draw sheet with handles for 2 caregivers (one per side) to elevate abdominal mass to access the perineal area (e.g., catheterization, wound care).
- To facilitate drying a patient between skin folds, use the air assisted lateral transfer aid to blow air or use a hair dryer on a cool setting.
- Use sealed high-density foam wedge to firmly reposition patient on side. Skid-resistant texture materials vary and come in set shapes and cut-your-own rolls. Examples include:
  - Dycem(TM)
  - Scoot-Guard(TM): antimicrobial; clean with soap and water, air dry.
  - Posey-Grip(TM): Posey Grip does not hold when wet. Washable, reusable, air dry.

- A multidisciplinary team needs to problem solve these tasks, communicate to all caregivers, refine as needed and perform consistently.
- Consider using an abdominal binder if the patient's abdomen impairs a patient handling task.

Algorithm 6: Bariatric Transporting (stretcher, wheelchair, walker)



- If the patient has respiratory distress, the stretcher must have the capability of maintaining a high Fowler's position.
- Newer equipment often is easier to propel.
- If patient is uncooperative, secure patient in stretcher.