

The tetraplegic patient and the environment

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Introduction

Over the past dozen years, progress in the rapid transport of patients with spinal cord injuries, improved effectiveness in resuscitation following trauma, and their very rapid transfer to specialty rehabilitation centers have led to improved survival rates and an increased life span for patients who suffer cervical spinal cord injuries.

The benefits afforded to patients in these specialty centers occur in two phases:

- the first is devoted to re-education to diminish the deficits associated with the spinal cord lesion; and
- the second is to enable psychosocial adaptation, the goal of which is to assist the individual's re-entry into his or her environment thus reducing the handicap brought about by the impairment.

The therapeutic plan is developed on the basis of the anticipated level of recovery. The new international classification of handicaps, defined by the World Health Organization (WHO) in 1990,¹ provides a conceptual framework for our methodology. It differentiates between an 'impairment', a 'disability', and a 'handicap':

- impairment describes the effects on an organ or organ systems and (in relation to spinal cord injuries) reflects the level of the spinal cord lesion;
- disability describes the limitations encountered in daily life, and corresponds to the functional consequences of the problem;

- handicap reflects the difficulties that result from the 'disability' or the 'impairment', and is itself linked to the environment and to social and cultural factors.

The impairment scale established by the American Spinal Injury Association (ASIA) in 1982 standardized the analysis of the motor and sensory levels. Evaluation of the disability in the tetraplegic patient is based essentially on the presence or absence of prehension, since this function determines independence. Evaluation of the handicap is more complicated, because it takes into account the characteristics of the environment of the patient, at the individual (personal), material, and structural levels, and of the patient's lifestyle (the values and central interests of the patient). This evaluation helps to limit the effect of the handicap through appropriate initial care and subsequent rehabilitation.

The therapeutic plan is developed over the course of several meetings. These include not only the patient, but also the mix of different professionals (physicians, occupational therapists, physical therapists, nurses, psychologists, and sociologists) who come together to define the short- and mid-term objectives that mark the stages of treatment of the patient.

Among these different professionals the occupational therapists occupy a central place, and intervene in all the stages of rehabilitation that benefit the tetraplegic patient. From the moment of admission,

they work to minimize the circumstances of the handicap with respect to the management of the patient's environment, principally the hospital room. In the phases of retraining they work to minimize the effects of the handicap through the development of directed activities. Finally, in the phase of rehabilitation they seek to diminish the functional consequences of the handicap by developing compensatory and assistive techniques. Occupational therapists also help to organize the return home of the patient, and take into account the patient's lifestyle to diminish the circumstances of the handicap at home.

Environment of the patient with spinal cord injury during the period of rehabilitation

This stage takes place in a medical environment imposed by consequences of the tetraplegic condition, but in keeping with the norms of treatment and rehabilitation. For the patients, this is a novel environment, far removed from their usual one.

In this period of evaluation assessments of the patient's needs are made, and the means and techniques of rehabilitation are put into place. This evaluation helps monitor the patient during his or her medical, functional, and psychological evolution, and

helps establish the necessary compensations and different adaptive devices.

This stage is designed to allow the patient to realize the maximum independence, assuaging the dependence on the nurturing circumstances of the hospital room, since in this facility there is access to automatic functions, technical devices, and human assistance. It is designed also to increase the patient's ultimate level of independence in the outside world and to assist him or her in utilizing all the possible compensatory skills and mechanisms.

The admission

At the time of admission, the initial treatment takes place in the patient's hospital room. The principal ergonomic goal is to allow the tetraplegic patient to signal the nursing staff or attendants, which strengthens the patient's sense of security. These patients have a motor deficit of greater or lesser significance that affects the upper limbs and necessitates adaptation of the existing calling devices, adaptations that can be activated by the upper limb or by the patient's head (*Fig. 5.1*).

The principal requirement of the patient and his or her family is to be able to use the telephone. How the telephone should be adapted depends upon



Figure 5.1 (A) A call-button on a flexible support to alert the nurse, controlled by the head. (B) A flexible call-button, hand controlled.

the specific motor circumstances of the patient: from a simple hand-held model to the utilization of a 'hands-free' telephone with keypad modifications to the use of an infrared controller.

Such an infrared system permits control of all aspects of the room's environment, including the telephone, television, radio, multimedia, lights, other electrical apparatus, window shades, and doors, and can also be used to signal the nurse. It consists of a programmable command system that recognizes the infrared codes of each function of the different devices mentioned above. The patient uses a contact switch attached to the head or upper limb or a voice command.

During this period in bed, the patient's other needs become prioritized, including access to reading materials, adapting simple command consoles, placing an adaptation on the upper limb to turn pages, or using more sophisticated devices such as an electric page-turner.

Moving toward independence

One must consider that a tetraplegic patient faces the difficulties of daily life (everything that happens from getting out of bed in the morning until going to bed in the evening) imprisoned within a wheelchair, with precarious balance, spasticity to a greater or lesser degree, the upper limbs weak, and little or no grasp. Even at night in bed the patient must worry about urination and protecting the skin by turning.

During this early stage of rehabilitation, the patient must understand that already, in the hospital, the goal is to achieve the maximum daily independence. Every possible assistance is given to the patient in this journey, in particular for movement and the elementary activities of daily life. Several modalities are offered:

- development of functional possibilities;
- adaptative and technical devices; and
- human assistance.

Mobility

Depending on the level of injury, tetraplegic individuals can acquire some level of independence in their mobility. An appropriate choice of wheelchair allows patients to enlarge their environment, and to move about on the ward and within the facility:

- an electric wheelchair is suitable for the high-level tetraplegic; and
- a manual wheelchair is suitable for the lower level tetraplegic (*Fig. 5.2*).

Table 5.1 describes the characteristics of the chairs, and the arrangement of the patient according to the functional level of the tetraplegic individual.

Basic activities of daily living

Drinking

It is very important for the tetraplegic patient to understand the notion of protecting his or her

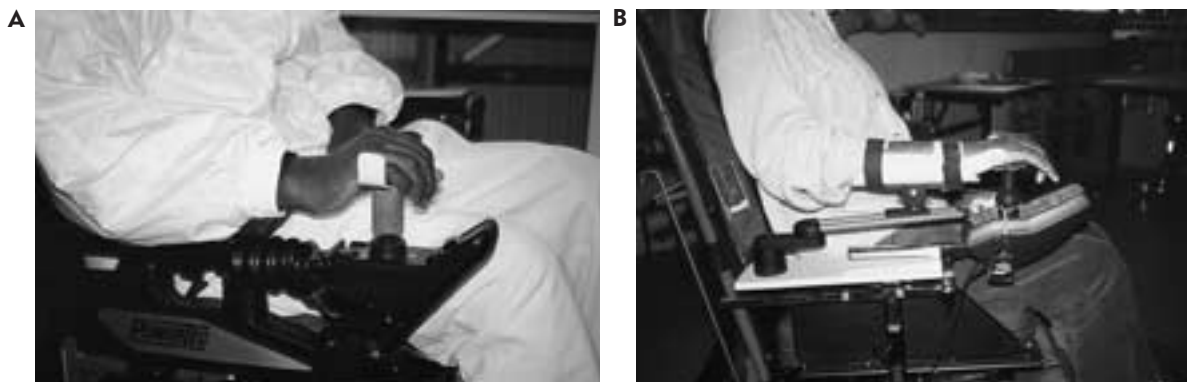


Figure 5.2 (A) Adaptation of a joy-stick controller to drive an electric wheelchair. (B) Driving using a mobile arm support.

Table 5.1 Wheelchairs for tetraplegic patients

Level of injury	Type of chair	Seating in chair	Control and propulsion	Transfers
C4	Electric	For trunk balance, high back and head support	Head command, occipital or chin	Third party and a lift
		For arm support, adaptable armrests	Access to all electric chair functions by electronics	
C5	Electric	For trunk balance, high back and head support	Hand command with adaptations for facilitating arm movements (mobile arm support) and adaptive joystick	Third party and a lift
		For arm support, adaptable armrests		
C6	Electric	Normal back support	Electric hand command with adaptive joystick	Transfer device with sliding board and third party, rarely alone
	Manual	Light manual chair	Hand propelled	
			Adaptive hand devices: non-skid rims, push gloves	
C7, C8	Manual	Light and sport model	Normal propulsion	Transfers alone, with or without sliding board

kidneys. No matter the circumstance (in bed or in the wheelchair), the patient must be able to obtain a drink when alone. If the patient cannot use his or her arms, the adaptation used is usually a flexible device, or a straw and support bottle. If the difficulty in gripping is only minimal, the patient can use an adaptive glass and bottle.

Eating

Independence in self-feeding is only really possible for the C6 level (and more able) tetraplegic patient in whom the deltoid and biceps are functional. A simple adaptive device, termed a metacarpal cuff (Universal or 'U' cuff), holds a fork or spoon, and can be adapted according to the motor potentials of each patient (Fig. 5.3). Such devices may be fitted to an orthosis that stabilizes the wrist when the wrist motors are weak or absent. The details of these adaptive devices deserve a case-by-case analysis for activities such as cutting meat, peeling fruit, opening a package, and arrangement for the patient at the table.

For the patient injured at the C5 level, the learning process is very lengthy. Its application is a function of

the strength of shoulder elevation, elbow flexion, and elbow release, and of the position of the arm and hand, particularly the extent of persistent forearm supination. Patients may be able to utilize an arm suspension or a mobile arm support. Patients injured at this high level will never be totally independent.

Hygiene and dressing

The ability to perform these activities is associated essentially with tetraplegic patients injured at the C6 level (those with functional deltoid, biceps, and radial wrist extensor muscles). The learning process is progressive and the progress becomes apparent as the patient acquires skills through sports, physical, and occupational therapy. Three identifiable activities include care of the face, body hygiene, and dressing.

Care of the face

The problems encountered by the patient include positioning him- or herself in front of the washbasin, access to the environment, gripping, and using objects. Difficulties in using the water faucets can be reduced by installing the type that automatically

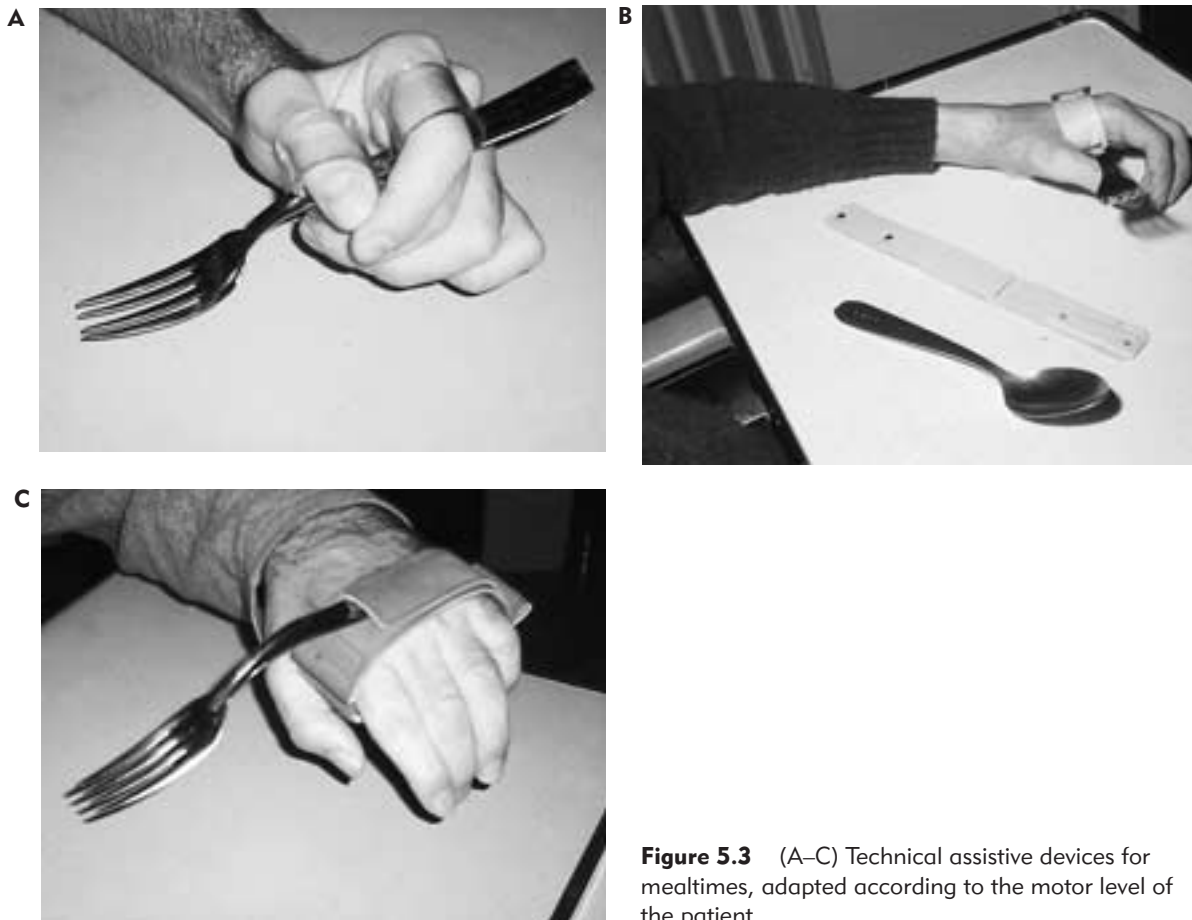


Figure 5.3 (A–C) Technical assistive devices for mealtimes, adapted according to the motor level of the patient.

mixes hot and cold water. Grasping hygienic devices (such as toothbrushes, toothpaste, hair brushes, razors, and makeup), can be facilitated by various adaptive devices, including universal cuffs, or rings, or by using different types of grips such as a bimanual grip (Figs 5.4 and 5.5).

For C5 patients who are essentially totally dependent, teeth brushing can be accomplished by combining an adaptive device with an orthosis that stabilizes the wrist, but some human assistance is necessary.

Personal hygiene

Personal hygiene may take place in bed or on the commode chair. In bed this necessitates turning over and sitting (which is achieved using a motorized bed), and the installation of an overhead frame, support, or sling. Nevertheless, the problems of preparing the

basic requisites, such as a basin, water, and towels, must still be solved.

On a commode chair the prerequisites include:

- sufficient balance;
- sufficient flexibility to lean the torso to reach the different areas of the body and the possibility of returning the torso from this leaning position;
- practical organization of the working area to reach the necessary objects; and
- ability to hold these objects (e.g., bath gel, shampoo, flannel) made easier by adaptive devices.

Dressing

In dressing, the upper part of the body is the most accessible when using supple clothing. Such things as buttons, snaps, or zippers present difficulties, which may be obviated with the use of Velcro closures.



Figure 5.4 A universal cuff for holding a razor.

Dressing the lower part of the body is a skill more applicable for the C7 and C8 tetraplegic patient who can expect to gain near complete independence. The C6 tetraplegic patient is very inconvenienced by an insufficiently strong or unstable tenodesis, limited sensation in the hand, and an absent triceps.



Figure 5.5 Adaptive tooth brush.

Inspection and prophylaxis

The patient must learn how to inspect him- or herself and to anticipate cutaneous and orthopedic complications (by giving appropriate attention to cushions, anti-bedsore mattress, padding pressure points, good chair condition, etc.). The daily environment of the patient can be modified in certain ways to increase comfort and safety. For example, preventing burns is emphasized in the bathroom by installing a combination faucet that controls the temperature of the water and, for the patient who smokes, by adopting different techniques for lighting a cigarette.

Sphincters

Emptying the bladder

The goal is to permit the tetraplegic patient to achieve self-catheterization, recognized as the best method of emptying. For some male patients, the occupational therapist works with the patient to find adaptive devices that facilitate the preparation and appropriate mechanics: adaptive aids to hold pants in the proper position, adaptive zippers, special mirrors, and technical aids to help grasp the catheter. For female patients, transfer from the chair to bed remains a significant obstacle to total independence in self-catheterization.

If there is no possibility of improving prehension, and thus being able to perform these activities, the tetraplegic individual will need to depend on another person.

Emptying the bowels

For the majority of tetraplegic individuals, this activity cannot be performed alone and therefore requires nursing assistance.

Transfers

Training in transfers is progressive:

- A strong, athletic C7 tetraplegic patient can recover to the same level as a paraplegic, in terms of bed mobility, self-care and hygiene, chair commode use, and driving a car.
- The C6 tetraplegic patient can achieve complete independence in transfers from the bed to chair. This requires compensating for the absence of triceps function by hyperextending the elbows and



Figure 5.6 Transfer assisted by a sliding board and an overhead sling (C6 tetraplegic patient).

careful balance. A transfer or sliding board facilitates this movement and lessens the risk of falling (Fig. 5.6). An aid may be needed for certain more difficult transfers, such as in and out of the car or the bathtub. Such instruction must be given on an individual basis.

Communication

Every method of communication should be studied and learned:

Handwriting

Handwriting should be possible using different writing implements adapted to the condition of the digits or, similarly, held in the mouth in patients with severe upper limb deficits. One example is a large felt



Figure 5.7 Adaptive writing aid (C6 tetraplegic patient).

pen held with two rings, one for the thumb and one for the index with the pen gripped between these fingers (Fig. 5.7). This does not allow normal handwriting, but it does permit the tetraplegic patient some independence in signing his or her name.

Manual or computer keyboard

Use of these devices is facilitated by different accessories, such as a mouth-held typing 'stick' for high-level tetraplegic patients, a universal or 'U'-cuff with an attached typing stick, a mobile arm support to enlarge the reachable area, or voice recognition systems (Fig. 5.8).

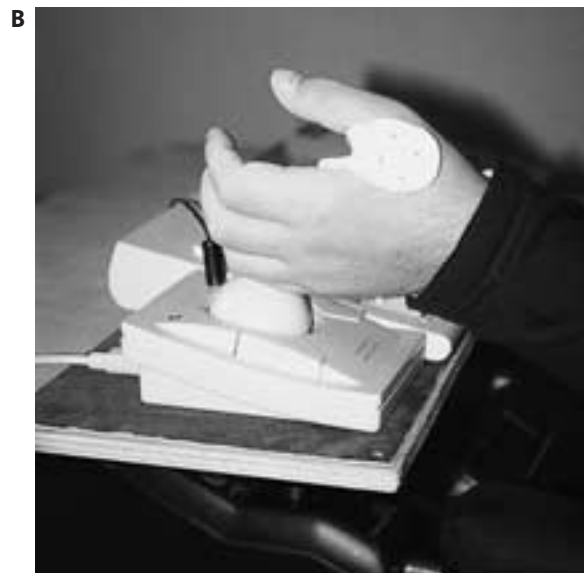


Figure 5.8 (A) Access to the keyboard of a computer. (B) Using a 'track-ball' to control a computer.

Telephone

A number of telephone designs are available, including 'hands-free' models, infrared command models, portable hands-free models, and a number of possible adaptations for holding the handset and dialing the number. Access to the Internet greatly facilitates communication for the tetraplegic patient.

Adjustment phase

The adjustment phase, termed 'readjustment', focuses on the patient's future plans for life, and is developed with the patient and his or her caregivers and family. The plan is based not on the circumstances of the care facility, but on the realities of the patient's future circumstances (in the place where the patient will actually live), relevant aspects of his or her past life, and the organization of treatment. This return to the usual social, family, and even professional structure hinges on different factors related to:

- coming back home and organization of the household;
- family relationships;
- social relationships;
- work (or school) and cultural interests, including the ability to move about in the outside environment.

The effort at readjustment is based on a careful evaluation of the acquired independence, outside conditions (e.g., the family, social, and work milieu), economic status, and the patient's habits. The circumstances of disability, as defined by all these elements, are more or less important; they determine the type of aids that must be put in place for different activities. The proposed solutions must take into account the patient's financial and personal considerations.

Organization of the home

Personal aids

The personal aids needed depend on the levels of family support and help from neighbors and on the level of assistance to which the person has access on a daily basis (nursing support, domestic support, meal preparation, and outside help). These aids apply to all the daily activities, including those related to the body (such as personal hygiene, dressing, feeding, sphincter

activities) and also to domestic activities (such as meal preparation, doing the laundry, developing budgets, etc.).

Material assistance

Material assistance includes not only the material and technical aids needed by the patient, but also those needed by the patient's attendant. Material assistance includes a hospital bed, anti-pressure sore mattress and cushion, washbasin, wheelchair, lifting hoist, sliding board, and so on.

Adjustments

All the elements in the individual's environment that represent obstacles to independence should be listed (doors too narrow, steps too high, slippery floors, inaccessible storage space, and unreachable light switches). Areas and items that may require adjustment include:

- access to the property, apartment, or house;
- hallway space in the domicile;
- work-space too high or too low (not enough space below for the legs);
- sanitation facilities (location, plumbing fixtures, access); and
- furnishings.

Animal aids

After training, a dog can accompany a tetraplegic person and can respond to some commands, such as fetch an object from the floor, open a door, sound an alarm, etc.

Moving about outside the hospital

In the course of readaptation, the tetraplegic individual will seek activities other than the usual routine and may turn toward the outside environment, including leaving his or her house to visit shops, banks, offices, and move about the sidewalks and streets. The individual's maneuverability in the outside environment should be sufficiently adapted such that he or she experiences the maximum independence. There are multiple obstacles, such as high sidewalks, uneven ground, more or less significant inclines, and dangerous walkways and streets.

Using a personal automobile or public transport, such as train, bus, subway, or plane, can augment moving over distances.

Public transport

Tetraplegic individuals often encounter many difficulties in terms of accessibility and human assistance: steep inclines, stairways, distances too great, height of the ticket counter, etc.

Personal automobile

Only tetraplegic patients at the C7/C8 level are truly able to drive an automobile with complete independence in transfers and in storing the wheelchair in the



Figure 5.10 Storing the wheelchair in the vehicle (C7 patient with surgical rehabilitation).



Figure 5.9 Adaptive driving using a fork on the steering wheel and a brake–accelerator lever.

vehicle (Figs 5.9 and 5.10). A C6 tetraplegic individual with good function of the upper limbs (or surgical rehabilitation of upper limb function) can expect to drive a vehicle. Table 5.2 describes the different adaptations and aids necessary for function according to the level of the tetraplegia.

When the individual cannot drive, he or she is transferred onto the passenger seat (either a personalized seat built into the vehicle or by using a pivoting seat). The individual can also stay in the wheelchair, for which a ‘van’-type vehicle is needed

Table 5.2 Vehicles for tetraplegic patients

Level of tetraplegia	Transfer into vehicle	Storing the chair	Driving
C7–C8	Accomplished alone, with or without sliding board	Performed by the patient with or without robotic arm adaptation	Automatic transmission
			Assistive steering and braking
			Fork or ball on the steering wheel compensates for prehension deficit
C6	Accomplished with human help and adaptive aids (e.g., sliding board or seated pivot and lift)	Accomplished by another person in the case of a transfer onto the seat of the vehicle	Brake and accelerate with hand control
	Installation to allow driving in the electric wheelchair		Satellite steering wheel or voice command for turn-signals, lights, horn, windshield-wipers, etc.

and a system with an elevated track or rail facilitates the tetraplegic's entry into the vehicle.

Leisure activities

Leisure activities deserve very careful study. The goal is to make leisure activities accessible, according to the level of the handicap. The occupational therapists must prepare many adjustments to leisure activities since the individual's return to work is more difficult or even impossible. Leisure activities are practical inside or outside the home. At home, leisure activities might include reading, watching television, games, music, and handicrafts. Outside the home, a number of activities are possible, including meetings, conferences, and cultural events such as the theater, cinema, museums, libraries, and art galleries. Sports activities are possible, through special sporting federations and associations. Sporting equipment needs to be accessible (e.g., gyms, swimming pools, and stadiums). In a similar sense, tourism is organized by special associations, and includes cruises, leisure clubs, amusement parks, and so on.

Associations

It is often the case that at the time of discharge from the rehabilitation facility, the handicapped individual and his or her family feel isolated for the first time. Paraplegia Associations facilitate meeting other paralyzed individuals and offer many benefits, including counseling and information, an exchange of experiences, materials and equipment, organized activities, vacations, and management of specialized services.

School and work activities

The most important condition necessary for professional or scholarly reintegration is the resolution (by different means) of the problems associated with the handicap, including difficulties in bodily activities, care, and movement.

School activities

When the schooling of an adolescent in the traditional manner is incompatible with the handicap, the funding or administrative agency may enable a change to a boarding school or day care in a specialty center

(offering both school and medical services). These offer schooling and a continuation of rehabilitation and care.

After 16 years of age, several solutions are available to the young person who cannot attend normal schools:

- continuing studies at a secondary school;
- going on to university; and
- pursuing an apprenticeship.

If the organization of daily affairs and accommodation can be assured, the adolescent can integrate into specialized structures such as advanced or professional schools.

Work activities

Resuming work is not possible unless there is:

- compatibility between the duties of the job and the individual's functional capacity; and
- the possibility of resolving specific management issues, such as accessibility, set-up of the work place, organization of daily care, and achieving the required freedom of movement.

The opposite circumstances necessitate a change helped by:

- a change of position within the same work environment; or
- job retraining and reclassification.

This can take place in a professional rehabilitation center or in the form of an apprenticeship at the employer's work place. In each case, patient motivation remains the determinant factor in the success of such projects.

About 'computers'

For the tetraplegic patient, the computer is a means of easy access to:

- leisure activities (games, culture, meetings, and discussions over the Internet);
- organizing the home; and
- organizing school and work.

The interface must be carefully chosen:

- computer mouse directed by head movement;
- adapted keyboard; and/or
- voice recognition.

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