

Rehabilitation path for patients with spinal cord injury from critical condition to optimal independence in everyday life on the example of the activities of the *Montecatone Rehabilitation Institute* in Italy

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Abstract

The purpose of this study is to present the activity of the *Montecatone Rehabilitation Institute* in Imola, Italy. The organisation of the Institute and the scope of multi-directional and multi-stage specialised assistance for people with a spine fracture with coexisting spinal cord injury, puts it at the forefront among the centres of this nature in Italy.

The most characteristic feature of the Institute is that patients go through the entire rehabilitation path in one place. This is important both for themselves and for therapists who can track patients' progress from severe condition to complete autonomy.

Another quality which must not be overlooked are the social, family and environmental aspects which facilitate a return to everyday life after a discharge from hospital. The role of the model where the patient is at the centre of the multidisciplinary team is very important in the process. The team includes an internist, pneumologist, anaesthesiologist, neurologist, physiotherapist, occupational therapist, nurse, health carer, educator, psychologist, speech therapist, social worker, peer consultant, volunteer.

Social organisations and foundations which cooperate with the institute on an ongoing basis, also play a very important role. They usually consist of former Montecatone patients who want to share their own experience as well as implement specific information projects related to, for example, social and legal advice. This allows the patients to stay in contact with the outside world.

Another option are sports activities outside the hospital. In this way, sport is used for rehabilitation and socialisation, and patients are getting ready for living outside the hospital.

Keywords: spinal cord injury, spine fracture, multi-stage rehabilitation, multi-directional rehabilitation

Introduction

The development of communication and technology makes us live faster and faster, and facilitates moving from one place to another in a short time, which results in a rise of the number of accidents each year. Car and motorcycle collisions, as well as accidents involving pedestrians and cyclists, are the main causes of spinal cord injuries,

together with falls from the heights (accidents at work or suicide attempts), jumping into water, as well as the increasingly common extreme sports [1].

Epidemiology

It is estimated that there live approximately 75,000 people with spinal cord injuries in Italy. Each year about 2,500 people become para- or

tetraplegic, 45% of which are due to traffic accidents, 20% due to accidents at work, 10% due to sports accidents, the remaining 25% due to various other reasons, including the use of firearms. 80% of these people are between the age of 10 and 40 with a very long life expectancy who bear very high social and personal costs.

Spinal cord injury

A spinal cord injury is a damage which causes temporary or permanent changes to the spinal cord's function. It can be traumatic due to mechanical forces, or non-traumatic, due to ischemia (caused by the lack of blood supply), cancerous lesions or other spinal diseases [2].

Outline

Alain Rossier (1930-2006), a paraplegic who promoted rehabilitation of people with spinal cord injury both in the USA and in Europe, said: ... "spinal cord injuries not only disturb the anatomical integrity of the spine, but also threaten the entire harmonious relationship between the various functional systems of the human being..."

The therapeutic approach, although related to individual needs, must be global and embraces medical, surgical, psychological and social aspects. The therapeutic program does not allow fragmentation, on the contrary, it must include:

- continuity of care / rehabilitation;
- the activities of both rehabilitation and medical care teams.

Pathogenic changes characterising the clinical picture refer to the primary, secondary and tertiary effects.

Primary – are an expression of a true cascade of biochemical events which support the logistic and immune response resulting from tissue damage.

Secondary – are an expression of the clinical picture that characterises spinal cord injury:

- a deficit in motor limbs,

- a deficit in feeling,
- a deficit of the impaired respiratory function (typical for a cervical injury),
- change in cardiovascular function,
- change in the gastro-etheric apparatus (paralytic ileus),
- uresis and stool disorders,
- functional area (rehabilitation project and rehabilitation program),
- psycho-social area.

The tertiary effects are:

- bedsores,
- infections of the urinary tract,
- osteoporosis,
- periarticular ossification,
- neuropathic pain (3).

Providing care

The methodology underlying the interdisciplinary treatment typical of the unipolar unit of the spinal cord injury ward relies on the team which has multiple tasks, such as:

detailed and multidimensional assessment of the patient, the analysis of needs, defining the rehabilitation objectives, active involvement of both patients and their families, proper organisation of relations with the outside units.

The continuous rehabilitation process can be divided into different periods:

* **the emergency phase**, relating to the period immediately after the event (generally within the first 12 hours after the injury) in which the objectives of the intervention are defined as follows:

- implementing all the procedures designed to limit the damage caused by the injury, generally critical to a person's homeostasis,
- protection of the spine which considered as potentially injured at the time of accident,
- treatment of a spinal cord injury to avoid neurological deterioration and create

optimal conditions for possible neuromotor recovery.

- * **acute phase**, relating to the period immediately following the emergency phase which lasts until the general clinical conditions are stabilised.
- * **stabilisation phase** or the so-called compensatory-regenerative phase, in which the general conditions are stabilised and possible instability of spinal lesions are limited with surgical or conservative measures (cervical collar, spinal jacket).

The average duration of this phase in the case of complete spinal cord injury is 4-6 months for paraplegics and 8-12 months for tetraplegics.

- * **post-discharge phase** or follow-up phase, characterised by the prevention and treatment of multiple complications which may occur after the discharge from hospital.

Acute phase

The acute phase provides for a high intensity of clinical and rehabilitation assistance, aimed at stabilising the patient from the haemodynamic, cardio-respiratory and nutritional points of view (percutaneous endoscopic gastrostomy is often required)

This phase lays the foundations for achieving maximum neuromotor regeneration and preventing or treating complications caused by a spinal cord injury.

At this point the path begins which will be continued and completed in the next phase of the clinical classification of all aspects related to spinal cord injury: neurogenic bladder, treatment of neuropathic pain, treatment of spasticity, approach to sexuality and fertility in people with spinal cord injury.

The next phase is characterised by the established clinical conditions and increasing levels of intensity of care and rehabilitation, including staff activities, active cooperation with

the patients themselves and, if possible, with caregivers identified in the meantime. The aim of this procedure is to achieve the maximum level of patients' autonomy, consistent with the degree of damage to the spinal cord and the socio-family environment in which the patients live [4].

Clinical framework

The most accurate way to predict the effects of the recovery is undoubtedly the standardised clinical evaluation with the Asia Scale and Asia Impairment Scale, as the International Standard for Neurological and Functional Classification of Spinal Cord Injury Patients suggests, and which refers to the exact determination of motor level, sensory level, neurological level and classification of impairment.

The ASIA results do not include proprioceptive sensitivity or the presence, absence or change of tendon reflexes, or the presence or absence of spasticity, which are measured separately with other scales.

Spinal cord injuries are divided into partial or complete.

Asia Impairment Scale (according to Frenkl)

A = complete/total: in sacral segments S4-S5 no sensory or motor function is preserved

B = neurological level and includes sacral segments S4-S5 sensory function but non-motor function is preserved below.

C = incomplete: motor function is preserved below neurological level, and more than half of the key muscles below neurological level have muscle grade below 3

D = incomplete: at least half of the key muscles below the neurological level have a muscle grade of 3 or more

E = regular

Incomplete, partial clinical syndromes, include: the half-lesion syndrome also called the Brown-Sequard syndrome, central syndrome, anterior

Patient Name _____
 Examiner Name _____ Date/Time of Exam _____

ASIA **STANDARD NEUROLOGICAL CLASSIFICATION** **ISCS**
AMERICAN SPINAL INJURY ASSOCIATION **OF SPINAL CORD INJURY**

MOTOR
KEY MUSCLES (scoring on reverse side)

R	L			
C5	<input type="checkbox"/>	<input type="checkbox"/>	Elbow flexors	
C6	<input type="checkbox"/>	<input type="checkbox"/>	Wrist extensors	
C7	<input type="checkbox"/>	<input type="checkbox"/>	Elbow extensors	
C8	<input type="checkbox"/>	<input type="checkbox"/>	Finger flexors (dorsi) (abduction of middle finger)	
T1	<input type="checkbox"/>	<input type="checkbox"/>	Finger abductors (diti) (finger)	
UPPER LIMB TOTAL (MAXIMUM)		<input type="checkbox"/>	+	<input type="checkbox"/>
		(28)	(28)	(56)

Comments: _____

L2	<input type="checkbox"/>	<input type="checkbox"/>	Hip flexors	
L3	<input type="checkbox"/>	<input type="checkbox"/>	Knee extensors	
L4	<input type="checkbox"/>	<input type="checkbox"/>	Ankle dorsiflexors	
L5	<input type="checkbox"/>	<input type="checkbox"/>	Long toe extensors	
S1	<input type="checkbox"/>	<input type="checkbox"/>	Ankle plantar flexors	
LOWER LIMB TOTAL (MAXIMUM)		<input type="checkbox"/>	+	<input type="checkbox"/>
		(28)	(28)	(56)

SENSORY
KEY SENSORY POINTS

= absent
 = impaired
 = normal
 NT = not testable

C2				
C3				
C4				
C5				
C6				
C7				
C8				
T1				
T2				
T3				
T4				
T5				
T6				
T7				
T8				
T9				
T10				
T11				
T12				
L1				
L2				
L3				
L4				
L5				
S1				
S2				
S3				
S4-5				

Any anal sensation (Yes/No)

PIN PRICK SCORE (max: 112)

LIGHT TOUCH SCORE (max: 112)

Voluntary anal contraction (Yes/No)

Zone of partial preservation (S4-S5)

ASIA IMPAIRMENT SCALE

NEUROLOGICAL LEVEL:

COMPLETE OR INCOMPLETE?

ASIA IMPAIRMENT SCALE

NEUROLOGICAL LEVEL:

COMPLETE OR INCOMPLETE?

ASIA IMPAIRMENT SCALE

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spinal artery syndrome, cauda equina syndrome, spinal cord concussion syndrome [5].

In order to develop a therapeutic process, it is necessary to define an overall functional balance which must consider numerous variables, such as the level of injury, residual motor activity and sensitivity, biographical and biological age, but also psychological characteristics, personality and aspirations of the patients, social aspects, family, school or work environment. This enables and facilitates the integration and regaining the autonomy of a person with a spinal cord injury.

Therefore, a model in which the patient is the CENTRE of an interdisciplinary team providing treatment is very important. It includes such professions as: doctors of various specialties: internist, anaesthesiologist, neurologist, pulmonologist, physiotherapist, occupational therapist, nurse, health carer, educator, psychologist, speech therapist, social worker, peer consultant, volunteer [6].

Personal experience of two years of work in the clinic (December 2016 - October 2018)

Many years of work in home therapy with patients after spinal cord injury has sparked my interest in deepening the knowledge in this subject and encouraged me to start working in one of the largest and oldest institutes in Italy. It is situated in the Emilia Romagna region and is located 413 kilometres away from my place of residence. Most of the patients come here from other, sometimes very remote, regions of the country. As it turned out, the Montecatone Rehabilitation Institute is a very important centre and a challenge for therapists thanks to its specificity, vast experience and a variety of cases.

It is characteristic of this place that the patients may be admitted very early, just a few days after spinal stabilisation surgery in neurosurgery wards in other hospitals. Montecatone has a well-equipped intensive care ward and, depending on their clinical situation, patients can be admitted

either to this ward or to the acuteward. Then they continue their rehabilitation in the subacute ward and are discharged home from there. This is very convenient for managing patients with spinal cord injury because from the very beginning they are under the care of a medical team specialised in this field, and the rehabilitation program may be continuous and take place in one centre. Also, from the psychological point of view, it is very beneficial for the patients themselves, because they get used to this place and feel safe there, which builds their positive attitude towards cooperation. The stay in the clinic is very long and varies depending on the type and level of spinal cord injury. Patients with severe damage stay here the longest, because they need respiratory support, and due to the paralysis of the chest muscles, these patients cannot cough up the accumulating secretion and therefore undergo machine-assisted physical therapy (cough assist machine). Their rehabilitation is more comprehensive also due to the paresis of the upper limbs. For patients with full quadriplegia, a special rehabilitation protocol is prescribed depending on the level of damage. The highest levels (C3 and C4) are characterised by a lack of neuromotor function and therefore complete dependence on others. The functional situation for each level will be different. The C5 level allows to use the so-called passive functional hand: it is a hand that, in the absence of active muscular work, must be able to perform light and functional grips by tenodesis of the flexor muscles of the fingers and a thumb; the palm and fingers gain a grasping function as a result of supination, the thumb is bent and adducted, the palm opens during pronation of the forearm and the thumb straightens and abducts, the wrist must be supported either by the presence of the extensor carpi radialis longus or by a wrist stabilising orthosis, which allows for the use of a passive functional hand with the help of biceps activity. To support the flexor tenodesis, the technique of

regular and periodic taping of the fingers in the flexion is used.

The C6 level is characterised by the presence of an active, functional hand: the grasping function is achieved with active wrist extension, followed by closing the fingers and flexing a thumb until the index finger is touched (lateral grasp).

At the C7 level, it is important to assess the presence of extensors which prevent shortening of the finger flexors; if only extensors are present flexing will be preferred, if both extensors and flexors are present strengthening exercises will be done in DLA (Daily Living Activities).

At C8, an active hand can be achieved if the flexors have a force of at least 3-4; the presence of a deficit in the small movements of the fingers often forces the patient to use enlarged, thick and soft grasps for daily activities. In addition to the correct positioning of the hand with static or dynamic orthoses, attention should be paid to rehabilitation through passive mobilisation, which must be implemented correctly and with sufficient frequency. To strengthen the selected muscles, electrotherapy using FESS (functional electrical stimulation) and a special Hand Master device are used. The hand may become flat or clawed as a result of improper proceeding, and the patient will lose the ability to fully use the hand in a functional manner.

The hospital is well prepared for the entire period of patients' stay, not only from clinical but also psychological, educational and social perspective. Many social organisations cooperate with the hospital to create and implement information projects related to, for example, social and legal advice. Most of the co-workers are former patients willing to share their experience with others who are still at the beginning of their journey and find it difficult to imagine life in a new situation. Such contact with former patients is very beneficial, because they are truly credible, showing, with their

own example, the progress which can be achieved. These people, despite having to use a wheelchair, lead a satisfactory life, build family relationships, have children, work, play sports and are socially active.

Patients' path

In the intensive and sub-intensive therapy ward, the patients are monitored, they undergo respiratory physiotherapy treatments, the proper positioning is maintained in order to prevent not only bedsores, but also contractures and deformations of the limb joints. Whenever possible, patients are seated in wheelchairs and verticalized with tilting tables. When their clinical condition is stable and they breathe on their own, the patients are transferred to the acute ward where the therapy is continued. Here, in the spinal ward, another team steps in, consisting of doctors, a nurse case manager and a rehabilitation case manager, physiotherapists, occupational therapists, and depending on the patient's needs, a plan for further therapy is developed after an appropriate assessment of the health condition. Each of these professionals has a part to play in organising the overall plan. The task of the case manager is to communicate with the family and cooperate with territorial centres, as well as to deal with matters related to ordering a wheelchair or personal orthopaedic orthoses, splints. The nurse case manager deals with the nursing aspects for the patient, cooperates with the family and local institutions. They both act as liaisons between Montecatone Hospital and the patient's family as well as the external institutions. In this ward, patients can undergo more intensive therapy tailored to their needs, the time of staying in a wheelchair is longer and they can move around independently. The rehabilitation procedure includes passive and dynamic verticalization, manual therapy and, above all, the use of neurophysiological concepts. Functional

exercises are very important so that the patient learns to change their position independently, to sit up, reach for the items they need, get the upper body dressed, take care of hygiene using the sink. As patients learn to be independent, the difficulty of the tasks increases. At this point, it is important to work with an occupational therapist who helps find ways and strategies to cope with this increase. Patients are taught to use the wooden boards very early and are expected to cooperate. There are mechanical hoists installed in each exercise room, but therapists try to use them only in difficult cases. Of course, the whole therapy is adapted to the type of patient, or rather to the height at which the spine has been damaged. The level of injury most affects the type of recovery. For a patient who is a paraplegic, the rehabilitation will consist in strengthening the upper limbs and stabilising the torso, such patients quickly learn to move independently, have efficient hands, so they have no problems with personal hygiene, but this does not mean that it is easier for them to accept the new situation and the necessity to use a wheelchair, so they often need the help of a psychologist. If the patients' health condition is good and, once they are thoroughly examined, they meet certain criteria, occupational therapy as well as hydrotherapy can be included in the program. Occupational therapy offers as many different sports as possible during the stay, also outside the hospital. Patients are transported by clinic-owned transport to various sports centres throughout the city, where they can participate in a variety of activities. In this way, sports are used for rehabilitation and socialisation with others. Among other things, patients can swim in the pool, practice at a target shooting range, play tennis, try archery, fencing, basketball and even sailing [7].

The rehabilitation program, apart from daily activities in the exercise room and static or active verticalization using the "STANDING", includes

walking exercises on anti-gravity treadmills and the exoskeleton. These are highly specialised devices. Two physical therapists are required to ensure the safety of patients during these exercises. Unfortunately, not all patients will be able to walk independently, but the very fact of standing upright is very important from the psychological point of view. Patients indicate the importance of eye contact without having to look up, since unfortunately, when sitting in a wheelchair, they have to look up when the other person is standing in front of them. There are special standing frames on the market for use in everyday life which the patients can use on their own or with the help of another person. Thanks to such frame, a paralysed person can stand upright with the help of an electric mechanism and move around the room (similar to an electric wheelchair) [8]. The role of a family is very important in the whole process of recovery, as its members are included in the therapy directly from the moment of the patient's injury and through all the phases of the rehabilitation process. A person from the immediate family or, if this is not possible, an outsider, is appointed as the "caregiver". Such a caregiver is adequately trained during the patient's stay in the hospital in order to provide the adequate care on their own after the patient has been discharged from the centre. Situations may vary and not all patients are able to return home. Those who are able to do so must prepare for it well, and the place to which they return must be adopted to their needs. It is advantageous to predict the patient's future level of independence (the situation is different for patients using an electric wheelchair, and different if they can use their hands). Therefore, it is a part of the patient recovery program to deal with their situation after leaving the hospital. A special field inspection is carried out, and if this is not possible, then architectural changes are developed using maps

and photographs. It is often impossible to carry out such construction works and return to live in the same place as before the accident. There are also many cases of people who, after being discharged from the hospital, moved to the city of Imola permanently due to the adaptation of the city's architecture to the disabled [9].

A brief history of the hospital

Montecatone Hospital was built as a health resort in 1934 on the beautiful hills of the city of IMOLA. In 1973, the first rehabilitation wards were opened, and in 1980, 50 patients could stay there and further 8 in the day care clinics.

Today, it is a rehabilitation hospital, accredited by the regional Emilia-Romagna health service institutions, and due to its comprehensive treatment of patients with spinal cord injury, it is a reference point for the entire region.

The centre has 150 beds for providing hospital care and 8 more for daytime intensive rehabilitation of people with spinal cord injuries and severe brain injuries.

The hospital consists of 5 operating units: intensive and sub-intensive therapy, acute and sub-acute spinal cord ward, ward for severe acquired brain injuries, multi-specialist care unit – a ward for patients with complications.

There is a well-developed outpatient unit where patients who have already been discharged from hospital are examined, primarily in terms of urology and spasticity control. Botulinum toxin treatments are performed on site, both for the bladder and for spasticity of the limbs. Patients are consulted with on-site specialists and solutions are sought in cooperation with specialists from other institutions. In the case of severe spasticity (Ashworth 4), patients are presented with the option of using a baclofen pump.

In some situations, Montecatone Hospital has the ability to collaborate with a surgical clinic and

refer patients to muscle transplant procedures, which allows them to regain functional movement of the upper limbs [10].

On the top floor of the complex there is a room for IT classes, where patients can use computers in their free time and there are volunteers who are ready to help. There are rooms here, too, where music, art and theatre workshops are held, organised by professional educators. In a situation where patients from acute wards cannot participate in group classes, an individual meeting with the educator is held in the patient's room.

On this floor there are also rooms where school classes are held for teenage patients. The hospital has an agreement signed with the education board that in the case of young injured patients, they are provided with individual education and do not lose the school year [11].

The hospital aids in obtaining a driving license and adjusting the car to the patient's needs, it is possible to simulate driving using a special device in the occupational therapy rooms. Once a month, you can also try out different types of assistance in real cars, thanks to the cooperation with the autodrome in Imola. As a result, patients receive appropriate information to make modifications in their own cars or decide to buy a new one, adapted to their needs.

It is also possible to take advantage of pet therapy in the hospital, where classes with an instructor and trained dogs are organised once a week.

The hospital complex also includes a guesthouse adapted to the needs of the disabled. Both families of the victims and the patients themselves returning to the clinic for the day rehabilitation/day hospital can stay in this building.

The guesthouse is also used for occupational therapy during the stay, as well as for preparing patients for discharge from the clinic. They undergo a test on how to manage outside the hospital, both

during the day and at night. There is a purpose-adapted bathroom in each room and patients have to use it on their own.

They also have the opportunity to prepare meals as part of therapy, using products previously purchased outside the centre. Such classes show how to move around outside the centre independently, do shopping and run daily errands, of course in the company of a therapist [12].

Conclusions

A spinal cord injury is a very serious condition, but a well-planned early rehabilitation program and surrounding the patients with a well-prepared team of professionals from the very beginning give them a chance to start a new life in a new situation and go through the entire rehabilitation path with the least possible trauma. What is more, the entire rehabilitation program should be flexible enough to enable adaptation to the individual needs of each patient. My stay and work at the Montecatone clinic was an unforgettable experience, which greatly improved my professional qualifications and emotional attitude. The institute is a challenge for therapists due to its specificity, great experience and variety of cases.

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