

Commentary

# The Impact of New Technologies on Rehabilitation Team: Ar ì a Experience

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#### Abstract

The advent of robots and artificial intelligences has the power to be revolutionary and, according to some, to undermine the very concept of work and human necessity in the production process or in the professions.

This is the report of 10 years of rehabilitation experience with robotic systems and new technologies for a rehabilitation team accustomed to traditional treatment.

This report does not concern the reliability of rehabilitation with robotics, but the impact that this new way of rehabilitation has had on a rehabilitation team. In the described experience it is evident that a metamorphosis of the mentality and the way of working of all the operators has taken place.

In a mixed environment it is the person and his unique value that establishes and hierarchizes the priorities: the robot cooperates with the man and not the man who assists the machine.

**Keywords:** Rehabilitation team; Robotic; New technologies; Artificial intelligence

## Introduction

The concept of neuroplasticity modified the rehabilitative approach to the patient with neurological deficit following a stroke or other CNS injury. The effectiveness of task-oriented rehabilitation was highlighted in the modulation of neuronal processes that favour the recovery of motor function.

The use of robotics in the rehabilitation field finds its meaning in the possibility of favouring the forced and repetitive use of a paretic or plegic limb.

Moreover, such equipment can be used with the simple supervision of the physiotherapist without intensive training leading to operator fatigue and therefore short treatment.

On the basis of these assumptions, a renovation project for the rehabilitation center was developed in Aria with the acquisition of robotic devices and the reorganization of work [1].

The key points of this project were; increase the intensity of treatment with the aim of reducing the length of hospital stay by increasing the number of patients and keeping the number of operating units unchanged.

Evaluate the patient's initial and final capacities rigorously using the measurement tools provided by the equipment. Promote the repetitiveness of the performance to increase its effectiveness.

#### Materials and Methods

Aria has a structure for hospitalization and outpatient treatment with the architectural characteristics of a residence rather than a medicalized environment. Rooms and common areas tend to favor the patient's idea of a home transition.

In the gym the robotics instruments were introduced: for the rehabilitation of the upper limb, the REO GO, ARMEO and AMADEO were acquired; for the rehabilitation of the lower limb the GANG TRAINER and LOKOMAT. Furthermore, the machines of VIRTUAL REALITY and the TREADMILL WITH BODY WEIGHT SUPPORT were acquired (Table 1).

|                                    | Starting date | Number of Operators<br>needed | Main using objectives            |
|------------------------------------|---------------|-------------------------------|----------------------------------|
| Lokomat                            | 2008          | 1 or more                     | Walk rehabilitation, Verticality |
| Treadmill with Body Weight Support | 2008          | 1                             | Walk rehabilitation, Verticality |
| GANGTRAINER                        | 2008          | 1                             | Walk rehabilitation, Verticality |
| ARMEO                              | 2008          | 1                             | Upper limb rehabilitation        |

| Reo Go                                             | 2008 | 1                                                         | Upper limb rehabilitation                                                      |
|----------------------------------------------------|------|-----------------------------------------------------------|--------------------------------------------------------------------------------|
| AMADEO                                             | 2008 | 1                                                         | Upper limb rehabilitation                                                      |
| Virtual Reality                                    | 2008 | 1 or more                                                 | Upper limb rehabilitation. Orthopedic rehabilitation, Cognitive rehabilitation |
| Balance System SD                                  | 2008 | 1                                                         | Orthopedic and neurologic rehabilitation                                       |
| BIODEX System PRO                                  | 2008 | 1                                                         | Orthopedic rehabilitation                                                      |
| Gait Trainer Treadmill 2                           | 2008 | 1                                                         | Walk rehabilitation                                                            |
| Balance System SD                                  | 2008 | 1                                                         | Orthopedic and neurologic rehabilitation                                       |
| REWALK                                             | 2015 | 2                                                         | Walk rehabilitation, Verticality                                               |
| WALKER-VIEW                                        | 2016 | 1                                                         | Walk rehabilitation                                                            |
| PLATFORM PROKIN-PK252                              | 2016 | 1                                                         | Orthopedic and neurologic rehabilitation                                       |
| Transcranial direct electrical stimulator starstim | 2016 | 1<br>Physiotherapist or 1 speech therapist or<br>together | Speech therapy combined with neurologic rehabilitation                         |
| EKSO GT                                            | 2016 | 2                                                         | Walk rehabilitation, Verticality                                               |

**Table 1:** List of new technologies introduced year after year in the rehabilitation gym, number of operators necessary for their use, main field of application.

This economic enterprise has been supported by some evidence of effectiveness that emerge in the literature.

Rehabilitation of the upper limb with a robot allows the therapist to individualize the exercise on the basis of the patient and furthermore the possibility to visualize the feedback promotes the patient's motivation and his adherence to the treatment. At the same time, the exact measurement of the performance is obtained

The exercise of the path by means of electro-mechanical means with load suspension obtains the result of improving the patient's gait with stroke outcomes if performed in combination with traditional physiotherapy. It is also a safe and comfortable robot for the patient

In the case of the use of Lokomat in patients with spinal cord injury, the research has not yet shown a certain efficacy but it seems necessary to identify the subpopulation of patients who receive greater benefit from this treatment as well as define the precise rehabilitation protocol and its duration.

Virtual reality offers the possibility of a task-oriented and repetitive exercise with the ability to involve the patient greater than traditional techniques [2,3]. The most varied exercises can be performed safely and even in the absence of the physiotherapist.

At Aria there are physiotherapists, speech therapists, neuropsychologist, 2 physiatrists and neurologists as well as nursing and auxiliary staff.

On average, 20 patients are suffering from neurological diseases and 12 from orthopedic diseases.

Treatment sessions take place in large gyms without separation of the workstations. Each patient follows 4 h of group and individual treatment per day. Neurological patients are also engaged in ADL training activities at different times of the day. They are followed and supervised during meals in the case of dysphagia. They carry out a group and individual logopedic treatment on a daily basis.

For each patient a rehabilitative project is drawn up during a multidisciplinary team and then shared with the family members.

## Results

Following the acquisition of the new rehabilitation tools, every physician, physiotherapist and speech therapist has been involved in dedicated training activities.

Physiotherapists were selected to be dedicated to assisted rehabilitation of the lower limb and others to the upper limb and some to virtual reality [4]. Doctors also received selective training. On the basis of the different training courses, different roles were then assigned to the gym.

According to the individual project each patient is treated with one or more machines by different physiotherapists and also receives a traditional individual treatment. The evaluation scales used are the same used before the introduction of robotics (FIM and FAM, Trunk Control Test, Motricity Index, Ashworth Scale and Barthel Index).

The physiotherapist's working method has changed. We went from the individual and traditional treatment of two hours a day for five days a week to that of a group for four hours a day for five days a week and two hours for the remaining two days of the weekend.

This resulted in a fragmented view of the patient by the operators. There was an increase in the overall workload and deterioration in working conditions caused by the need to coordinate a group of six patients by monitoring the activity of some of the machines and individually treating one patient at a time.

The operators do not have protocols for the application of the new machines since they are not yet defined. The specific attribution of the

use of a robot for prolonged periods (six months on average) determines an impoverishment of the quality of work by those used to work manually and directly with the patient.

The burden of training on the use of robots has been added to the ordinary workload, which continues over time with the progression of skills. The physician had to include in the rehabilitation project the use of one or more robots based on the type of patient and must compare with the group of physiotherapists who individually followed the path.

In the gym the figures of the basic health assistants were also included where simple surveillance of the patient is required while using the machine.

The degree of overcrowding of the gym has increased as well as the background noise produced by those present and the machines. The patients were enthusiastic about the increase in length of stay in the gym and the possibility of using new machines.

Even relatives put a lot of hope in this method of work. The rehabilitation team faces the difficulties of transition exactly as in the eighteenth century the workers faced with the industrial revolution.

The type of previous organization was based on the concept of rehabilitation distributed over 24 hours with a holistic approach to the person rather than the district. In the transition to a mixed rehabilitation method of robotics and manual treatment, this unitary model has been temporarily lost.

#### Discussion

In bioethics the term neuroscepticism has been coined to describe the attitude of negation towards what neurotechnology is developing on the basis of cognitive evolution in neuroscientific field [5-7].

Aria's rehabilitative team did not show such an oppositional attitude but given the long and positive experience in traditional rehabilitation, it found it difficult to accommodate all the various robotics devices simultaneously and to manage and use them in a profitable way for the patient. Despite obvious difficulties, the rehabilitation team showed interest in new technologies acquired with great commitment to training for their use.

In the following 10 years the exoskeleton was introduced too for the rehabilitation of the walk both of individual with spinal cord injury and after stroke [8]. Studies have shown promising results regarding the reduction of pain perception and spasticity level; improvements in sitting posture, intestinal, cardiorespiratory, metabolic, tegmental and psychological functions.

After 10 years from the introduction of new technologies in the daily work of rehabilitation, we observe a change in the attitude of the operators, an increase in the use of machinery, the improvement of the ability to use them, an awareness of the operators and patients about the limits and potential of robotics.

The initial skepticism of physiotherapists has given way to a mature awareness of the potential of new technologies and an increased appreciation of their irreplaceable role. It has become clear that the synergy of robotics and traditional treatment is very useful to the patient and also improves the quality of the physiotherapist's work.

In 10 years since the introduction of new technologies, about five physiotherapists decided to change their workplace and one chose to change the type of work. Patients are very curious about new machines, are more stimulated and are satisfied with the treatment and results. Even older patients and family members after the initial enthusiasm understand the real role of robotics and appreciate the treatment.

For example, in walk rehabilitation, the exoskeleton allows to start the ambulatory training early even for sustained times and this reinforces the traditional treatment and improves the final results. Other review supported the evidence that for lower limb patients with severe impairment, robotic training produces better outcomes than conventional training. In upper limb robotic rehabilitation, training seems to improve arm function in activities of daily living [9,10].

The increasingly emerging request of patients is to be able to autonomy in the recovery path and the technological avant-garde are walking in this direction [2,3]. The rehabilitation team will therefore be called in the future to educate and accompany the patient to a therapeutic path outside the hospital and dropped into daily and domestic reality.

Faced with this new challenge, it is necessary to know and master what is offered by bioengineering without losing the wealth of rehabilitative experience stratified over the years and the concept of individualisation of recovery paths.

It is clear that once robotics is adopted, it is necessary to keep up with the technology and always experiment with the new avant-gardes.

The function of robotics in rehabilitative interventions has been examined extensively, generating positive yet not completely satisfactory clinical results. Studies conducted do not demonstrate the decisive effectiveness of new methods for functional recovery of neurological patients, but it has been proven that robots are an important resource when associated with traditional rehabilitation. The treatment plan must then be individualized based on the goals wanted.

We can understand industrial revolutions as the appearance of new forms of general purpose technologies: the first industrial revolution is linked to energy as a force to produce work that has made the production revolution possible through the introduction of vapor machines. The second industrial revolution used new forms to produce work with the advent of chemistry and electricity. The third revolution, thanks to electronics, telecommunications and informatics.

The world of work today knows a new frontier: interactions and coexistence between men and artificial intelligences. In the development of artificial intelligences (AI) the disclosure of the successes obtained by these machines has always been presented according to a competitive model compared to man. These media appearances of the AI could make us think that these are systems that compete with man and that between Homo sapiens and this new machine sapiens has established a rivalry of evolutionary nature that will see only one winner. In reality these machines have never been built to compete with man but to create a new symbiosis between man and his artifacts. AI is not the threat of human extinction even if technology can be dangerous for our survival as a species. However, there are extremely delicate challenges in contemporary society in which the most important variable is not intelligence but the limited time available to decide and cognitive machines find great applicative interest here.

At this level, a whole series of ethical problems are opened up on how to validate the machine's cognition in the light of the speed of the response that one tries to implement and obtain. However, the greatest danger does not come from the AIs themselves, but from not knowing these technologies and letting them decide on their employment to someone that is absolutely not prepared to manage the issue.

## Conclusion

This report does not concern the reliability of rehabilitation with robotics, but the impact that this new way of rehabilitation has had on a rehabilitation team. In the described experience it is evident that a metamorphosis of the mentality and the way of working of all the operators has taken place. Operators faced change positively, discovering the potential of working with robotics and increasing the certainty of the value of traditional rehabilitation. In fact, the traditional treatment must necessarily support the assisted robot rehabilitation. Currently it is the conviction of the rehabilitation team that it is necessary and also interesting to acquire new technologies and deepen more and more experience and specific training.

In a mixed environment it is the person and his unique value that establishes and hierarchizes the priorities: the robot cooperates with the man and not the man who assists the machine [9].

If the working horizon of the near future-in reality already of our present-is a cooperation between human intelligence and artificial intelligence and between human agents and autonomous robotic agents it becomes urgent to try to understand how this mixed reality, composed of agents autonomous human beings and autonomous robotic agents, can coexist.

In the 10 years of working experience with robotics, physiotherapists, doctors and all operators have developed a mode of relationship with the machines that have ensured an optimal use of new technologies for rehabilitation and a consolidation of the certainty of their irreplaceable role in customizing and applying the rehabilitation project.

The real challenge for rehabilitation operators is to have a considerable amount of data, supplied by the machines, which can be

processed with statistical tools to understand, for example, the usefulness of a robot for a patient [11,12].

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