8th EPOS BAT Basic III Instructional Course - Vienna-Speising – March 13th, 2025

Evolvement in the Treatment of Neuromuscular Disorders over the last decades

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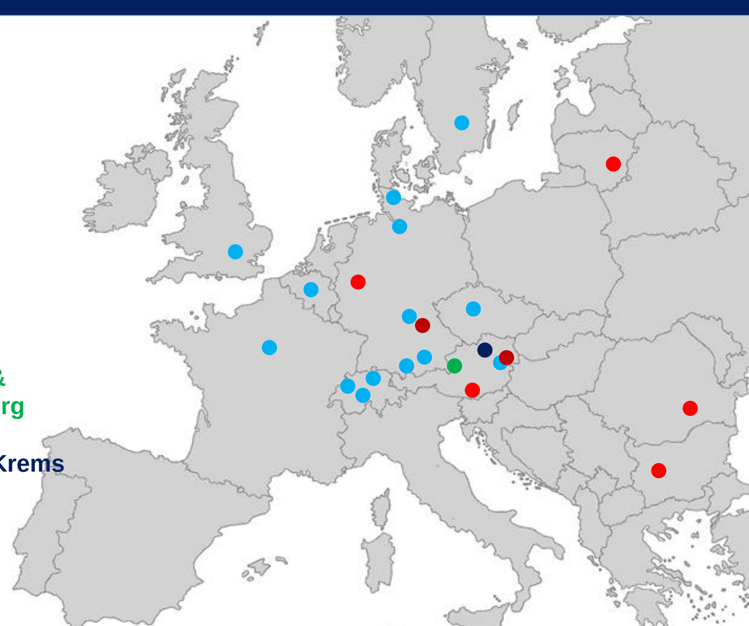
UNIKLINIKUM SALZBURG

PARACELSUS MEDIZINISCHE UNIVERSITÄT

MOTIO Fortbildungsinstitut

Evolvement in the Treatment of Neuromuscular Disorders

I have nothing to disclose.



Affiliations:

- Pediatric & Neuro-Orthopedic Clinic & Paracelsus Medical University Salzburg
- University for Continuing Education Krems
- Educational & scientific cooperation
- MOTIO Institute Vienna & Nuremberg
- Clinical & scientific cooperation

Evolvement in the Treatment of Neuromuscular Disorders

“Plan for the future, because that is where you are going to spend the rest of your life.”

Mark Twain (1835 Missouri – 1910 Connecticut)

„Our future is based on our past.”

Paul Valery (1871 Séte – 1945 Paris)

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

What you will learn

1. **How have neuromuscular diseases been treated in the past**
2. **1980s – how interdisciplinary approach improves treatment outcome**
3. **1990s – how digitalisation enables networking & quality assurance**
4. **2000s – how 3D-gait analysis & BoNT give a deeper understanding of biomechanics**
5. **2010s – how muscle power training reduces pain & enhances motor learning**
6. **2020s – how genetics & AI enable personalised treatment protocols**
7. **Future – what we may expect?**
8. **Diskussion**

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Evolvement in the Treatment of Neuromuscular Disorders

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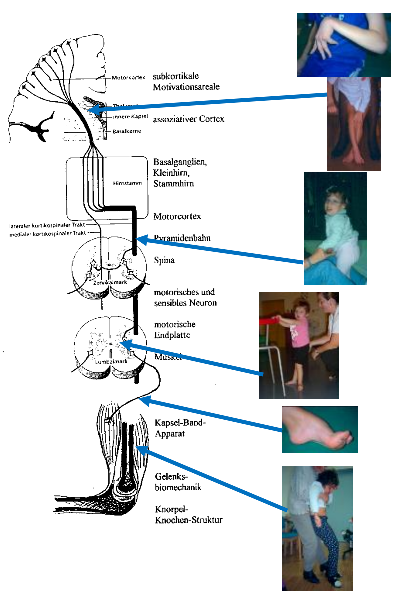

Hemiplegia following stroke	**500 A.D.**
Tetraplegia following stroke, brain injury TBI	
Diplegia (CP, encephalitis, HSSP,…)	
Bilateral Spastic Cerebral Palsy BSCP	**1862**
Dystonia, dyskinesia	
Akinesia (Parkinson,…)	**1817**
Spinocerebellar ataxia (Friedreich,…)	**1863**
Cerv./thor./lumb./sacr. Paraplegia (MMC,…)	**1769**
Spinal muscular atrophy SMA	**1893**
Amyotrophic lateral sclerosis ALS	
Poliomyelitis anterior	**1838**
Secondary toxic neuropathy	
Hereditary motor.-sensor. neuropathy HMSN (CMT,…)	**1887**
Progressive muscular dystrophy (DMD,…)	**1850**
Congenital myopathy, arthrogryposis	**1841**
Myasthenia, myotonia	

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases

2800 B.D. Papyrus describes traumatic tetraplegia as 'untreatable'

1500 B.D. Egyptian depiction of a unilateral toe-walking patient

400 B.D. Hippocrates describes the correction of clubfoot and the reduction of various dislocations

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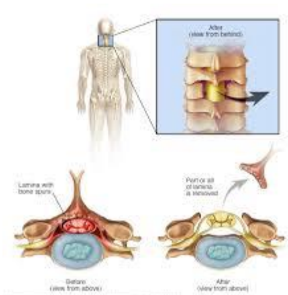
Evolvement in the Treatment of Neuromuscular Disorders

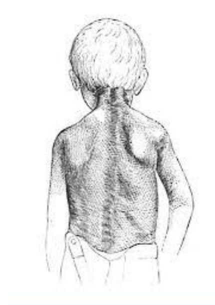
Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases



632 A.D. Paul of Aegina describes laminectomy for traumatic spinal cord compression

1768 A.D. Smellie describes obstetric plexus palsy



1838 A.D. Heine reports treatment result of surgery for muscular torticollis

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

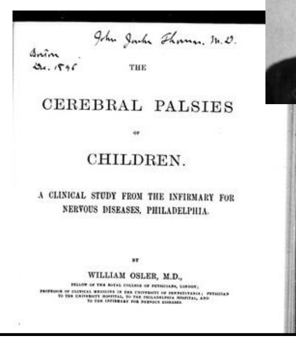
Early past of treating Neuromuscular Diseases – 1860s

William John Little (1810-1894)

1862 description of spastic palsy causing delay in motor development

Sir William Osler (1849-1928)

1887 first book on "cerebral palsy"



THE

CEREBRAL PALSIES

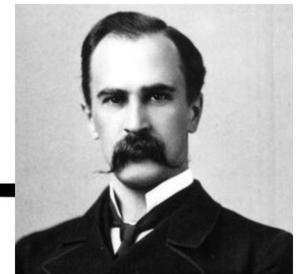
OF

CHILDREN.

A CLINICAL STUDY FROM THE INFIRMARY FOR NERVOUS DISEASES, PHILADELPHIA.

BY

WILLIAM OSLER, M.D.,



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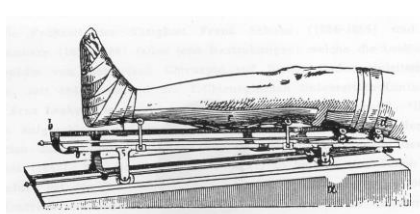
Evolvement in the Treatment of Neuromuscular Disorders

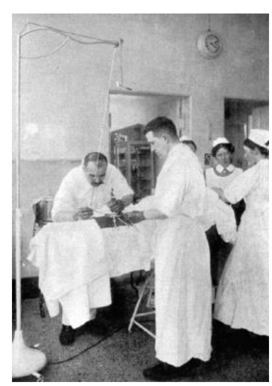
Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1880s

1813 Ling publishes Swedish therapeutic gymnastics

Johann Dumreicher (1815-1880) develops the 'railway apparatus'





Karl Nicoladoni (1847-1902) performs first tendon transfer in 1881

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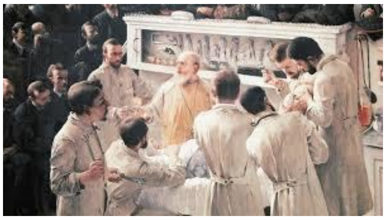
Evolvement in the Treatment of Neuromuscular Disorders

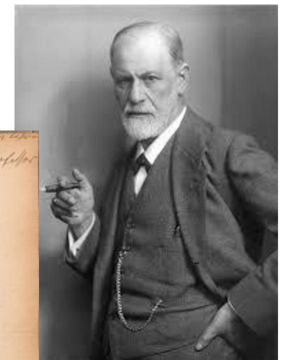
Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1890s



1885 Konrad Billroth: 'The tailor is the best orthopaedist'

1897 Sigmund Freud: 'The therapy of infantile cerebral palsy is a poor and desolate chapter'



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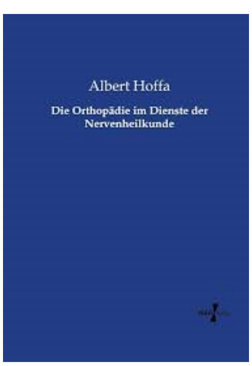
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1900s



'Orthopaedics in the service of neurology'

Albert Hoffa (1859-1907 Würzburg & Berlin)

'We find ourselves here in a field of our activity that was previously little known, but whose development promises the most beautiful fruits!'

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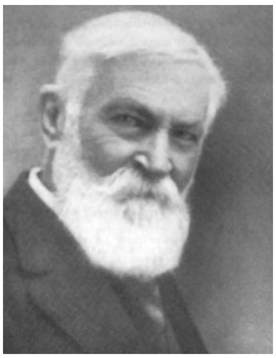
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1900s



Adolf Lorenz (1854-1946)
publishes on neuro-orthopedic topics

1901 Hoffa & Lorenz founded the German Society for Orthopaedic Surgery

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1900s

1907 Wittek
founded Austrian rehabilitation center "Heilstätte Stolzalpe"
founded 'Verein für Krüppelfürsorge'
begin of publicly organised care for the physically disabled

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1910s

Clemens v. Pirquet, Julius Wagner-Jauregg, Erwin Lazar, Anna Freud, Hans Asperger, Viktor Frankl, Andreas Rett

The first institute for curative education in Vienna in 1911

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1910s

1915 Hans Spitzy
founded Orthopedic Hospital Speising & Red Cross Hospital Istanbul with rehabilitation institutions

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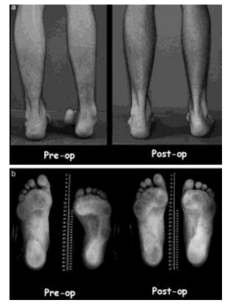
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases – 1920s



Arthur Steindler (1878-1959)
describes percutaneous plantar fasciotomy for progressive cavo varus foot
1907 Chicago and Iowa City
1933 Chairman of the American Orthopedic Association

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases - 1940s

AACPDM

Earl Carlson, Bronson Crothers, George Deaver, Temple Fay,
Meyer Perlstein, and Winthrop Phelps
founded the American Association for Cerebral Palsy as the first
inter-disciplinary professional organization in Chicago in 1947

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

Early past of treating Neuromuscular Diseases - 1950s

Neurodevelopmental Therapies:

Bobath
Castillo-Morales
Chiropractic
CIMT
Conductive Education Petö
Cranio-Sacral-Therapy
Feldenkrais
Hippotherapy
Kabat
Macmillan
PNF
Osteopathy
Root
SI Jean Ayres
Vojta

Karel und Berta Bobath

1958 Neurodevelopmental Treatment

May 1958 OCCUPATIONAL THERAPY 19

An Assessment of the Motor Handicap of Children with Cerebral Palsy and of their Response to Treatment

By

KAREL BOBATH, M.D. (Prague), D.P.M.
Assistant Physician, Brookwood Hospital, Knaphill, Surrey

and

BERTA BOBATH, F.C.S.P.
Principal, The Western Cerebral Palsy Centre Limited, London.

Children with cerebral palsy present many problems which require a team of specialists for their assessment. In considering these problems one must remember that one deals with a child, a total personality with special needs, emotional, intellectual and social. A true evaluation of the child's condition requires the study of his place in the family as well as measuring the extent and quality of his physical handicap, both sensory and motor.

This paper is intended only as a contribution to the assessment of the child's motor handicap and of his response to treatment. Many attempts have been made to assess the motor handicap of children with cerebral palsy and to evaluate the improvement made during treatment. Phelps (1953), for instance, tests individual muscles, classifying them into spastic, flaccid, rigid and normal. Progress in treatment is assessed in terms of improvement of function of the individual muscles. This classification does not take into account the fact that a lesion of the brain does not affect single muscles, but leads to an impairment of the co-ordination of muscle action. It disregards the fact that a muscle which may be too weak to contract in one position of the limb or body, can be made to contract strongly in another position. For instance, a child may be unable to contract the triceps when the head is turned away from the arm, but he may extend the elbow easily if the head is turned towards the arm. Or the tibialis anticus may not contract when the leg is extended, but may do so when the child is kneeling, that is, with flexion of the leg at all joints. These examples can be multiplied and show that a chart of the power of single muscles cannot give a true picture of a child's motor impairment and of progress in treatment.

Crosland (1951), measures skills rather than muscle power. Improvement is measured in terms of an increase in the number of skills after a period of treatment, regardless of the quality of their performance. Crosland expresses the view that it does not matter how the skill is performed as long as the child can do it in some way. The performance can then be corrected later on.

Other workers, among them Schwartz, Zuck and Johnson from the Edith Hartwell Clinic, New York (1952), have made use of motor age tests designed for normal children as a standard scale to record functional improvement in children with cerebral palsy. These tests measure the age level of a performance, its speed, the number of repetitions and mistakes made. They do not, however, measure the quality of the performance.

A skill is of a complex nature and it is often very difficult to assess the quality of its performance and to analyse any deviations from the normal. Even if a task is performed abnormally, it is not possible to measure the degree of abnormality. These difficulties of assessment can be overcome by measuring the quality of the simple basic movements which underlie all our skills. These movements, such as turning over from supine to side- and prone-lying, lifting the head in prone and supine, sitting up, sitting, using the hands for support, standing up and standing, etc., develop in a definite sequence. Normal co-ordination of these basic movements and the maintenance of balance during all these activities precedes the higher and more complex skills such as walking, and the independent use of the hands. Unless the child with cerebral palsy acquires normal co-ordination of these basic movements he cannot perform the higher skills, or he can do so only in an abnormal manner. The cause of the

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s Future

New technologies and the historical context trigger
new treatment methods

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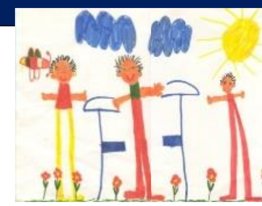
Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future



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7. Future – what we may expect?
8. Diskussion

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Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

An interdisciplinary team approach improves treatment outcome

New technologies:

- In-house databases in specialised institutions
- MRI
- Advanced film technology
- International exchange
- Foundation of international scientific societies

EPOS 1982 Paris

Treatment topics:

- Interdisciplinary consultation
- Cinematographic evaluation of gait
- Reducing spasticity
- Recognising deformities
- Correction of deformities

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Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

An interdisciplinary team approach improves treatment outcome

Neurolog. clinic & rehabilitation

Hotel, restaurant, educational facilities

Orthopedic clinic & orthotics & rehabilitation technology

Village with 200 barrier-free & assisted flats and workplaces

Training centre for 40 professions

Rummelsberg, Germany

Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

An interdisciplinary team approach improves treatment outcome

Bushby K, Finkel R, Birnkrant DJ, et al. Diagnosis and management of Duchenne muscular dystrophy, part 1: diagnosis, and pharmacologic and psychosocial management. Lancet Neurol 2010;9(1):77–93.

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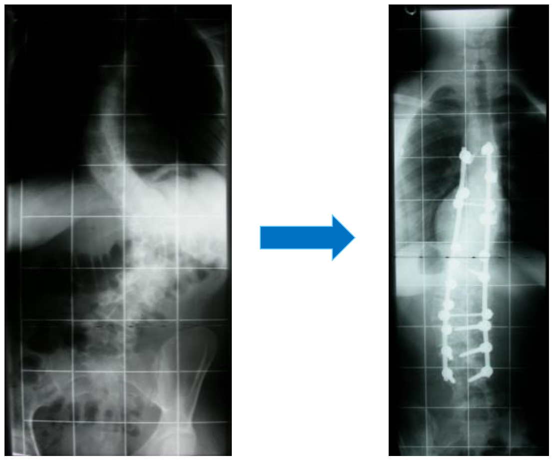
Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

Spondylodesis improves sitting posture and cardiopulmonary function

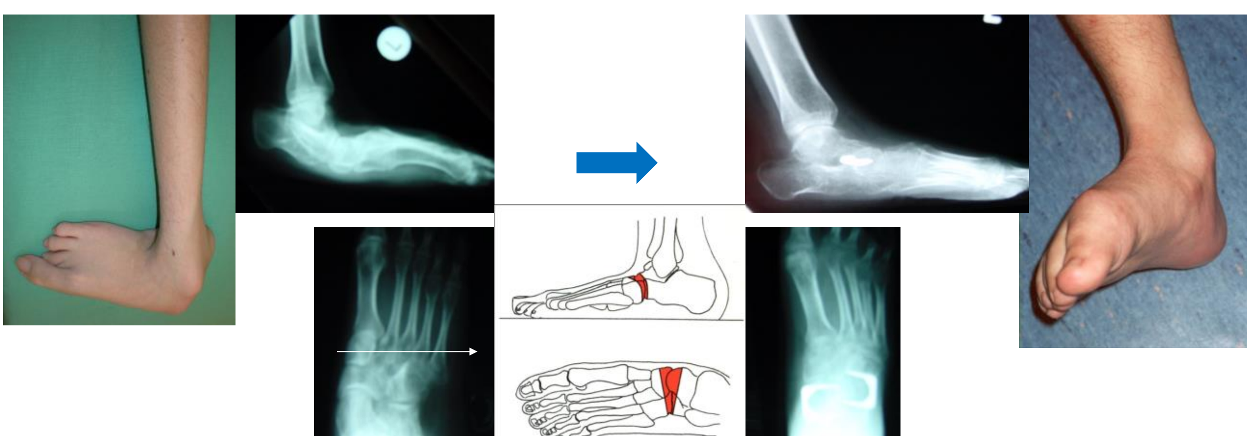


Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

Painful flat foot deformity -> reconstructive foot surgery

Pain relief & walking ability following medial plantar closed-wedge osteotomy & peroneal transfer

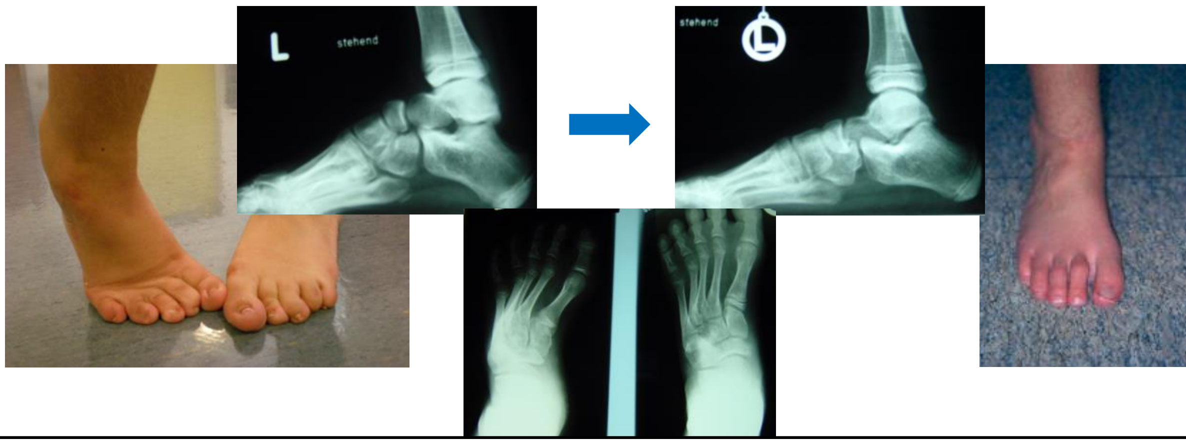


Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

Painful club foot deformity -> reconstructive foot surgery

Pain relief & walking ability following dorso-lateral closed-wedge osteotomy & posterior tibial transfer



Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

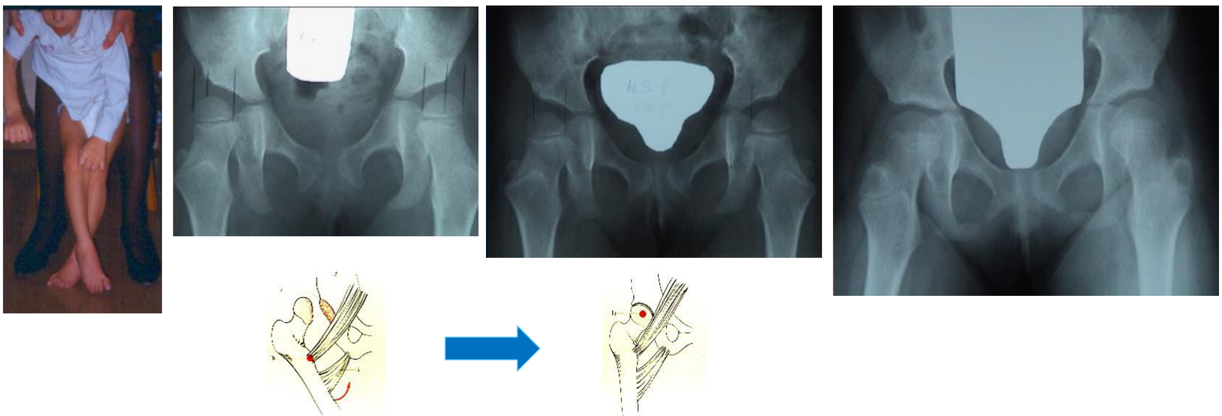
Painful cavovarus foot deformity -> reconstructive foot surgery

Pain relief & improved walking ability following dorsal closed-wedge osteotomy & Jones procedure

Evolvement in the Treatment of Neuromuscular Disorders

Early past **1980s** 1990s 2000s 2010s 2020s Future

Multilevel soft tissue surgery improves hip development



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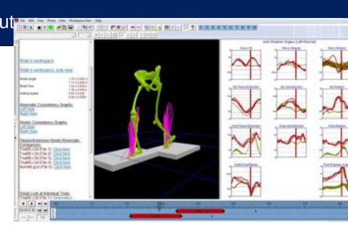
Early past 1980s **1990s** 2000s 2010s 2020s Future



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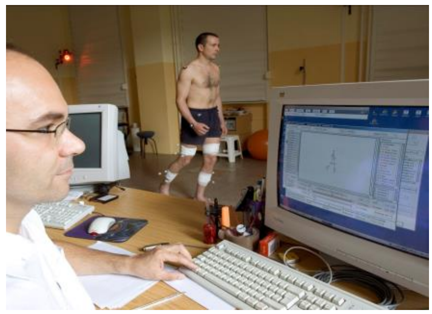
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s **1990s** 2000s 2010s 2020s Future

Digitalisation enables networking & quality assurance

New technology:

- **World Wide Web**
- **First internat. databases**
- **Health economics**
- **Quality assurance**
- **Start of 3D-Gait Analysis**
- **Quantitative gait evaluation**



Treatment topics:

- **Reducing spasticity by:**
- **Botulinum Toxin**
- **Intrathecal Baclofen Pump**
- **SDR**
- **Preventing deformities?**
- **Prevention programs**

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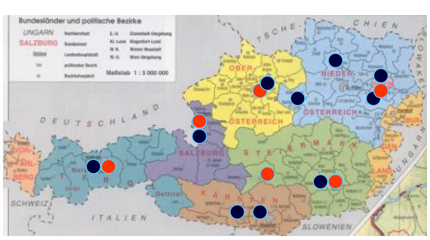
Evolvement in the Treatment of Neuromuscular Disorders

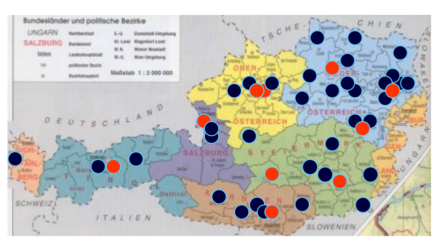
Early past 1980s **1990s** 2000s 2010s 2020s Future

Digitalisation enables networking & quality assurance

Expansion of nationwide highly specialised examination and treatment of NMD



1990



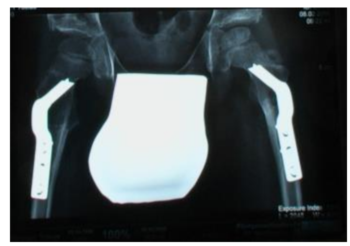
2018

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s **1990s** 2000s 2010s 2020s Future

Pain-free & stable hips following hip reconstruction





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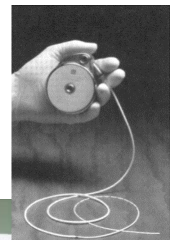
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

3D-gait analysis & BoNT give a deeper understanding of biomechanics

New technology:

- **First internat. databases for diseases**
- **Start of multi-center outcome studies**
- **Mid-term outcome by 3D-Gait Analysis**



Treatment topics:

- **Pain & Quality of Life**
- **Are BoNT, ITB, and SDR able to prevent spasticity and progressive deformities?**
- **Do we want to weaken or strengthen muscles?**

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

Pain & Quality Of Life in Children with Disabilities

Caretaker‘s perception does not meet child´s perception

“ … Group differences in overall ratings of quality of life were not significant; … Within the group with CP, functional ability was not associated with quality of life … ”

Vinson J, Shank L, Thomas PD, Warschausky S
Self-generated Domains of Quality of Life in Children with and Without Cerebral Palsy.
J Dev Phys Disabil. 2010 Oct 1;22(5):497-508.

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

Pain& Quality Of Life in Children with Disabilities

Caretaker‘s perception does not meet child´s perception

“ … both self-reported mental health and HRQL was better than proxy-reported by mother´s . Recurrent musculoskeletal pain was associated with more mental health problems and reduced HRQL in self-reports, but not in proxy-reports.”

Ramstad K, Jahnsen R, Skjeldal OH, Diseth TH
Mental health, health related quality of life and recurrent musculoskeletal pain in children with cerebral palsy 8-18 years old.
Disabil Rehabil. 2012 Feb 22.

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

Pain & Quality Of Life in Children with Disabilities

Caretaker‘s perception does not meet patient´s perception

Jahnsen, 2003 Norway
Young adults with Cerebral Palsy

N = 406 patients, mean 35a (18-72a)
GMFCS I-II 45%, II-III 40%, IV-V 15%
Method: subjective self assessment

„ … twice as much chronic pain, esp. musculoskeletal pain, three times more frequently chronic fatigue, …“

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Vitious Cycle Of Developing Deformities

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

Pain & Quality Of Life in Children with Disabilities

Prevention programms needed for:

Risk of

- **Hip dislocation**
- **Kypho-Scoliosis**
- **Joint contractures**
- **Arthritis**

in

- **Stroke patients**
- **Cerebral palsy**
- **Spinal disorders**
- **Neuropathies (HMSN)**
- **Muscle diseases**
- **Collagene disorders**
- **Arthrogryposis**
- **Syndroms**

In Europe approx. 30.000 new per year

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

3D-Gait analysis identifies muscle weakness as the main problem

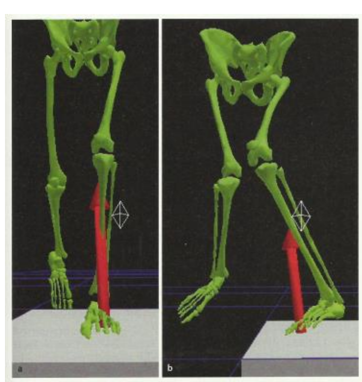
… abnormal muscle activity in orthopaedic patients who had no neurological involvement.
… Muscle weakness was the most important cause of the abnormal EMG activity.
… The triceps surae muscle, represented by the medial gastrocnemius, was significantly more involved.
… Co-activity of the knee extensors and hamstrings …
… These findings illustrate mechanisms to compensate for muscle weakness in stance in neurologically intact subjects.

Brunner R[1], Romkes J.
Abnormal EMG muscle activity during gait in patients without neurological disorders.
Gait Posture. 2008 Apr;27(3):399-407. Epub 2007 Nov 19.

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

3D-Gait analysis identifies muscle weakness as the main problem



Normal forces

Pathologic forces cause hyperactivity of muscles

Lack of motor control

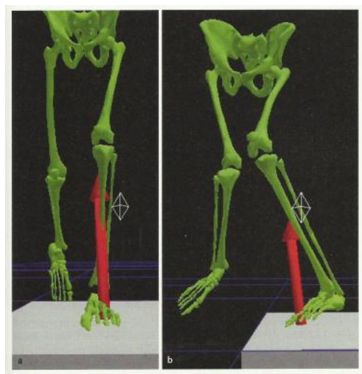
Spasticity

Contractures and deformities

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

3D-Gait analysis identifies muscle weakness as the main problem



Normal forces

Pathologic forces cause hyperactivity of muscles

Loss of motor control

⬇

Weakness of muscles

⬇

Instability with biomechanical disorder of posture and movement

⬇

Compensated by increased muscle tone

⬇

Disturbance of equilibrium, non-use, and overuse increase spasticity and development of contractures

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s **2000s** 2010s 2020s Future

Consequences for treatment

- Stabilisation of joint axis
  - **Ankle 90°, knee 0°, hip 0°, spine**
  - **Dynamic orthotics**
  - **Lever arm-restoring surgery**
- Strengthening of muscles
  - **Strengthening exercises**
  - **Shortening and reconstructive surgery**
  - **BoNT-injectons in antagonists**
  - **Dosed lengthening of antagonists**
- Avoiding muscle weakening
  - **SDR only in selected cases**
  - **BoNT only in selected cases**
  - **Lengthening by multilevel surgery in selected cases**

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

What you will learn

1. How have neuromuscular diseases been treated in the past
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7. Future – what we may expect?
8. Diskussion

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Muscle power training reduces pain & enhances motor learning

New technology:

- First national register´s longterm outcome studies
- Long-term outcome by 3D-Gait Analysis

Treatment topics:

- BoNT & ITB cannot prevent development of deformities
- Underestimated pain
- Muscle power training
- Minimal-invasive surgery
- Improving Orthotics

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Muscle power training reduces pain & enhances motor learning

Causes of pain

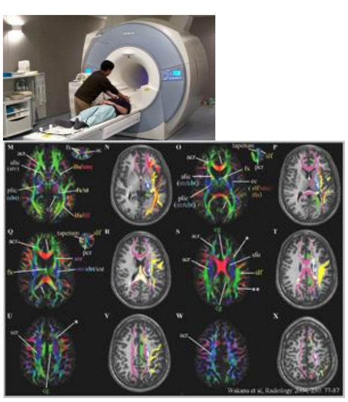
- **Non-use**
  Lack of active & passive muscle training causes „neurogenic neuroinflammation“
- **Over-use syndrome**
  Lack of control & weakness cause compensatory muscle activity & hyperactivity
- **Deformities**
  Malalignments of extremities and spine cause pressure pain
- **Spasticity, dystonia**
  Involuntary movements cause pain

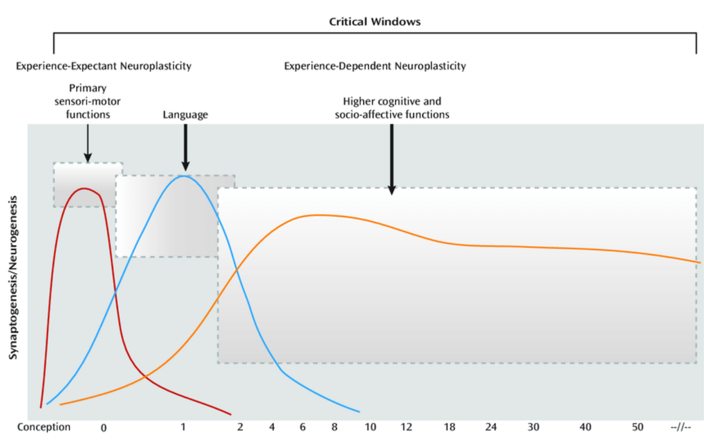
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Muscle power training reduces pain & enhances motor learning

Time windows for neuroplasticity





Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

The use of minimally invasive techniques in multi-level surgery for children with cerebral palsy: preliminary results

Thompson N[1], Stebbins J, Seniorou M, Wainwright AM, Newham DJ, Theologis TN.
[1]Oxford Gait Laboratory, Nuffield Orthopaedic Centre, Headington, Oxford OX3 7LD, UK. nicky.thompson@noc.nhs.uk
J Bone Joint Surg Br 2010 Oct;92(10):1442-8. doi: 10.1302/0301-620X.92B10.24307.

This study compares the initial outcomes of minimally invasive techniques for single-event multi-level surgery with conventional single-event multi-level surgery. The minimally invasive techniques included derotation osteotomies using closed corticotomy and fixation with titanium elastic nails and percutaneous lengthening of muscles where possible.
A prospective cohort study of two matched groups was undertaken. Ten children with diplegic cerebral palsy with a mean age of ten years six months (7.11 to 13.9) had multi-level minimally invasive surgery and were matched for ambulatory level and compared with ten children with a mean age of 11 years four months (7.9 to 14.4) who had conventional single-event multi-level surgery. Gait kinematics, the Gillette Gait Index, isometric muscle strength and gross motor function were assessed before and 12 months after operation.
The minimally invasive group had significantly reduced operation time and blood loss with a significantly improved time to mobilisation. There were no complications intra-operatively or during hospitalisation in either group. There was significant improvement in gait kinematics and the Gillette Gait Index in both groups with no difference between them. There was a trend to improved muscle strength in the multi-level group. There was no significant difference in gross motor function between the groups. We consider that minimally invasive single-event multi-level surgery can be achieved safely and effectively with significant advantages over conventional techniques in children with diplegic cerebral palsy.

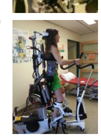
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Clinical studies 2010s

1. **Frequent movement in-between fascias reduces development of contractures.**
2. **Early surgical programms may reduce percentage of hip dislocations down to 0%.**
3. **Rediscovered minimal-invasive surgical techniques facilitate postoperative mobility and painfree exercises.**
4. **New implants permit full weigth-bearing postoperatively.**
5. **Perioperative adjustment of dynamic orthoses helps to reduce immobilisation.**
6. **Verticalisation reduces spasticity and improves brain metabolism.**
7. **Locomotion and whole-body-vibration facilitate neuronal integration.**
8. **Robotic-assisted locomotion therapy enables early postoperative training with guided legs and joints.**
9. **Power exercises and repetitive training show positive effects on daily life activities, reduction of pain, and quality of life.**




Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Muscle power Training

Training of muscular power

- **signif. findings in peripheral and central pareses**
- **Dodd et al. 2002; Darrah et al. 1997**

Repetitive Training

Repetitive training

- **signif. improvements of motor functions**
- **Bütefisch et al. 1995; Sterr et al. 2002**

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Whole Body Vibration Therapy

Whole Body Vibration (WBV) in CP patients

"… may be a useful tool for improving muscle strength and balance in children with diplegic cerebral palsy."

Effect of whole-body vibration on muscle strength and balance in diplegic cerebral palsy: a randomized controlled trial.

El-Shamy SM. Am J Phys Med Rehabil. 2014 Feb;93(2):114-21.

Evolvement in the Treatment of Neuromuscular Disorders

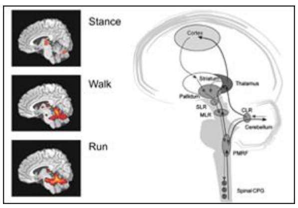
Early past 1980s 1990s 2000s **2010s** 2020s Future

Locomotion Therapy

Walking training with partial weight bearing

efficient in stroke and CP patients

Hesse et al. 1998



Challenge the Boundaries

Early mobilisation by locomotion therapy following minimally invasive multi-level surgery for children and young adults with cerebral palsy

STROBL W, SCHUSEIL J, SENGHAAS P, KOLLASCHINSKI M

Clinic for Pediatric & Neuro-Orthopaedics Rummelsberg - Germany
Danube-University Krems - Austria
walter.strobl@motio.org

Prospective controlled cohort study to evaluate changes of function, activity and participation in patients with bilateral spastic cerebral palsy after Robot-enhanced repetitive treadmill therapy.

Schroeder AS Eur J Paediatr Neurol. 2014 Jul;18(4):502-10

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Locomotion Therapy

Starting postoperatively:

- **1-2 days following**
  - **minimal-invasive SEML surgery**
- **3-5 days following**
  - **Tendon transfers with joint stabilization**
  - **Ostotomies/locking plates < 50 kg BW**
- **4 weeks following**
  - **Osteotomies/locking plates > 50 kg KG**
  - **Foot reconstruction surgery with joint stabilization**
- **6-8 weeks following**
  - **hip reconstruction surgery incl. open reduction, bilat. pelvic osteotomies**

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

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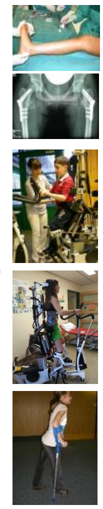
9. **Power exercises and repetitive training show positive effects on daily life activities, reduction of pain, and quality of life.**
10. **Education programs for patients and parents improve knowledge, confidence, compliance, and outcome of treatment.**



Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s **2010s** 2020s Future

Treatment Concept

- **Specialised interdisciplinary clinic**
- **for children & adults with CP**
- **Prevention programs**
- **3D-gait lab**
- **ICF-diagnostics**
- **Minimal-invasive (open & percutaneous) surgery**
- **Locking plates implant systems**
- **Perioperative fitting of orthoses**
- **Early mobilisation by locomotion and vibration therapy**
- **Rehabilitation & sports**
- **Network of caretakers**
- **Education for patients and parents**

EPOSNA 2017

Minimal invasive multi-level surgery allows early mobilisation by locomotion therapy in children and young adults with cerebral palsy

STROBL W

Clinic for Pediatric & Neuro-Orthopaedics Rummelsberg - Germany
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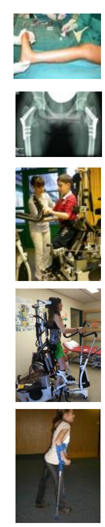

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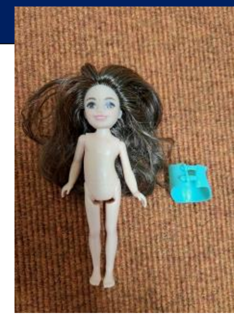
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future



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7. Future – what we may expect?
8. Diskussion

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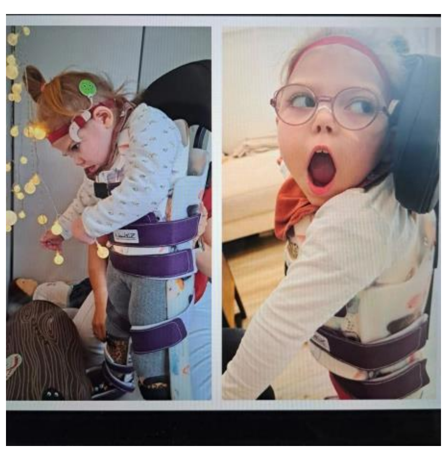
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Genetics & AI enable personalised treatment protocols

New technology:

- First international databases for rare diseases
- Genetic diagnostics
- Gene therapy
- Tools that use artificial intelligence



Treatment topics:

- Early gene therapy
- Very early physiotherapy
- Detecting pain
- Preventing non-use, hyperactivity, and pain
- Using AI-tools for personalised diagnostics and treatment protocols

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Genetics & AI enable personalised treatment protocols

- **„Cerebral palsy“ is not a diagnosis anymore**
- **Genetic diagnostics allows identification of the underlying causes**
- **Rare forms of diseases may be classified and treated in a personalised way**
- **Gene therapies may allow causal treatment approaches**
- **Very early training in the first months of life may allow prevention of secondary damage**
- **Risks for secondary damage may be assessed**

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Disease-modifying treatments

SMA	**Nusinersen**	**-> production of SMN protein**
SMA	**Onasemnogene**	**-> sustained expression of SMN protein**
SMA	**Risdiplam**	**-> production of SMN protein**
DMD	**Deflazocort**	**-> antiinflammatory**
DMD	**Prednisone**	**-> antiinflammatory**
DMD	**Ataluren**	**-> translation of full-length dystrophin**
Fabry	**Agalsidase beta**	**-> decreases accumulation of Gb3**

Laurane Mackels, Laurent Servais.The Importance of Early Treatment of Inherited Neuromuscular Conditions. 2024 Mar 5;11(2):253–274. doi: 10.3233/JND-230189

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Disease-modifying treatments

Early treatment in neuromuscular diseases can prevent severe complications and can be life-saving.

Acting in the early stages, before extensive function loss, is clearly beneficial in SMA for example. Delaying treatment can significantly reduce its efficacy, making timing crucial for optimal results in conditions like SMA and IOPD.

The ideal therapeutic window for Fabry disease requires further investigation, and the impact of early treatment in DMD is still being evaluated due to clinical heterogeneity.

CMS patients can benefit from life-saving symptomatic treatment, emphasizing the importance of raising awareness about these rare conditions and the need for broad genetic testing.

Laurane Mackels, Laurent Servais.The Importance of Early Treatment of Inherited Neuromuscular Conditions. 2024 Mar 5;11(2):253–274. doi: 10.3233/JND-230189

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Disease-modifying treatments

When considering early treatment, aspects such as response variability, cost, and safety must be taken into account.

Stronger evidence is needed to support early intervention in several conditions, but the low incidence of rare diseases poses challenges to obtaining reliable data.

Systematic reviews and meta-analyses can help summarize evidence, but they have limitations and biases.

Finally, NBS is a powerful tool that has the potential to revolutionize the course of diseases where early intervention is crucial.

Laurane Mackels, Laurent Servais.The Importance of Early Treatment of Inherited Neuromuscular Conditions. 2024 Mar 5;11(2):253–274. doi: 10.3233/JND-230189

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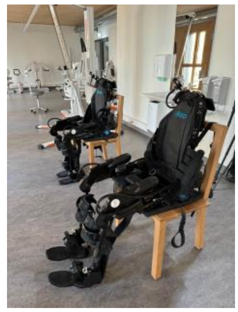
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Robotics supports and gathers data for AI rehabilitation programs





Robotic training for upper and lower extremities, simulating walking and horse riding

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s **2020s** Future

Very early treatment < 6 months

„Infants commencing intervention at <6 months corrected age had greater improvements in hand function.“

Randomized Comparison Trial of Rehabilitation Very Early for Infants with Congenital Hemiplegia

Roslyn N. Boyd, MSc PT, PhD, Susan Greaves, BSc OT, PhD, Jenny Ziviani, BSc OT, PhD, Iona Novak, BSc OT, PhD, Nadia Badawi, MD, PhD, Kerstin Pannek, PhD, Catherine Elliott, BSc OT, PhD, Margaret Wallen, BSc OT, PhD, Catherine Morgan, BSc PT, PhD, Jane Valentine, MD, PhD, Lisa Findlay, BSc OT, Andrea Guzzetta, MD, PhD, Koa Whittingham, PhD, Robert S. Ware, PhD, Simona Fiori, MD, PhD, Nathalie L. Maitre, MD, PhD, Jill Heathcock, PhD PT, Kimberley Scott, PhD PT, Ann-Christin Eliasson, BSc OT, PhD, and Leanne Sakzewski, BSc OT, PhD
J Pediatr 2025; 277: 114381

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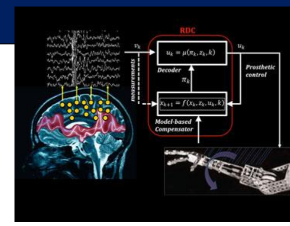
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**



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8. **Diskussion**

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

What we may expect?

1. **More precise & earlier diagnosis**
2. **More causal therapies –> other pediatric orthopedic disease patterns**
3. **More datas about very early training of muscular function**
4. **Prevention of non-use, compensation, hyperactivity, deformities, and pain**
5. **Improved social partizipation**
6. **Registers and access to institutions**
7. **Profound change in research – e.g. automated meta-analyses, …**
8. **Profound change in education – e.g. utilisation and control of AI**

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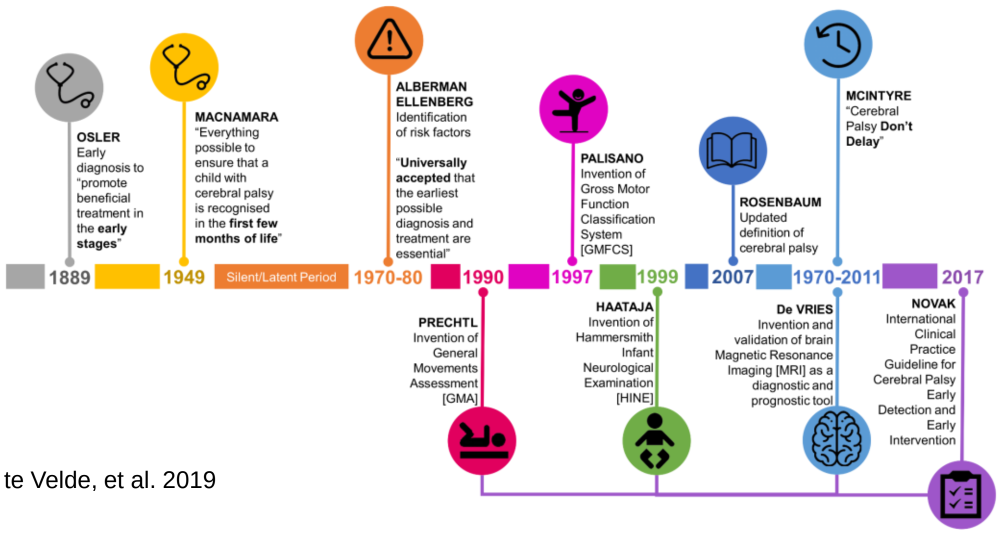
Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

History of early diagnosis of cerebral palsy



Anna te Velde, et al. 2019

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

History of prevention of secondary damage in cerebral palsy

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

History of prevention of secondary damage in cerebral palsy

Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

We look forward to your contribution

Special Issue

Cerebral Palsy in Children: Improving Quality of Life and Preventing Painful Musculoskeletal Disorders

Guest Editors
Prof. Dr. Walter Strobl
Dr. Mathilde Sengölge

Deadline
30 June 2025

children

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

Take Home Message

1. Make it easier for patients with NMD to access healthcare services
2. Acquire knowledge about the limits of normal sensorimotor development
3. Enable precise & early diagnosis
4. Start a very early treatment
5. Try to prevent non-use, compensation, hyperactivity, deformities, and pain
6. Work interdisciplinary in a multi-professional team and pass on your knowledge

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

Take Home Message

7. Be critical about fashion trends in diagnostics & treatment

„The greatest obstacle to discovery is not ignorance, it is the illusion of knowledge.“

Stephen Hawking (1942 Oxford – 2018 Cambridge)

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Evolvement in the Treatment of Neuromuscular Disorders

Early past 1980s 1990s 2000s 2010s 2020s **Future**

Take Home Message

8. Be brave and think outside the box

„What the herd hates most is the one who thinks differently; it is not so much the opinion itself, but the audacity of wanting to think for themselves, something that they do not know how to do.“

Arthur Schopenhauer (1788 Danzig – 1860 Frankfurt a. M.)

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8th EPOS BAT Basic III Instructional Course - Vienna-Speising – March 13th, 2025

Thank You!

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