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ARMEO THERAPY CONCEPT IS BACKED BY 15 YEARS OF CLINICAL RESEARCH

SUMM

1. The Armeo Therapy Concept is one of the most investigated approaches for upper extremity rehabilitation
2. The Armeo Therapy Concept can be safely and effectively conducted in several patient groups
3. Technology-assisted arm training improves activities of daily living, arm function and arm strength
4. Fifteen randomized controlled trials report positive results
5. The arm weight support maximizes the patients' motor functions
6. The Armeo Therapy Concept allows increased training intensity and repetitions
7. Training with Armeo devices provides long-term benefits
8. Augmented Performance Feedback increases motivation
9. The Armeo Therapy Concept offers objective assessments

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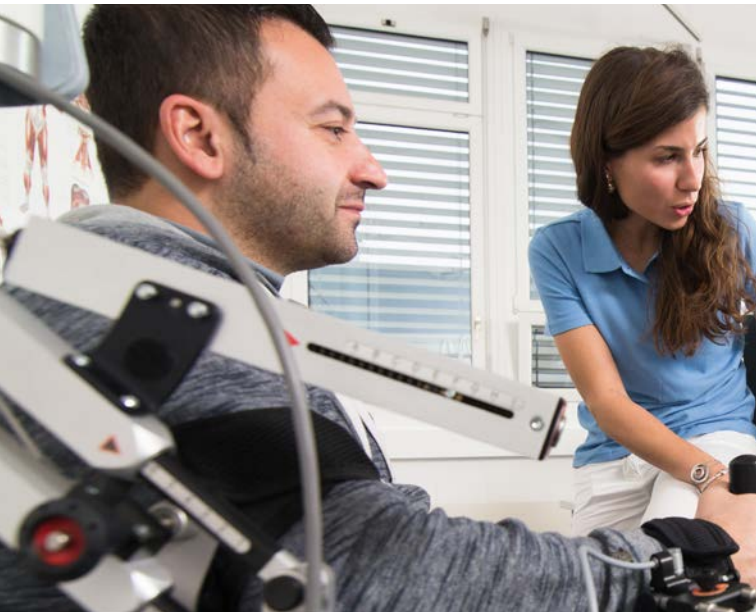
1

THE ARMEO THERAPY CONCEPT IS ONE OF THE MOST INVESTIGATED APPROACHES FOR UPPER EXTREMITY REHABILITATION



- The Armeo Therapy Concept is included in 144 research articles published in peer-reviewed journals from independent research groups worldwide (as of January 2019).
- These studies include 17 randomized controlled trials (RCTs), 53 clinical trials other than RCTs, 40 reviews and guidelines and 31 technical papers.

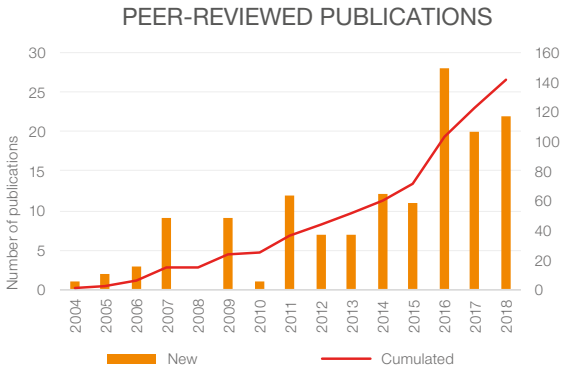


Figure 1: Interest in the Armeo Therapy Concept is high and still growing.

2

THE ARMEO THERAPY CONCEPT CAN BE SAFELY AND EFFECTIVELY CONDUCTED IN SEVERAL PATIENT GROUPS

A Stroke, all severity levels [1-18]

B Spinal cord injury [19-21]

C Multiple sclerosis [22, 23]

D Acquired brain injury [24-26]

E Cerebral palsy [26-30]

F Amyotrophic lateral sclerosis (ALS) [31]

G Humerus fractures [32, 33]

The Armeo Therapy Concept has also been applied to individuals with Guillain-Barré syndrome [21, 34] and its feasibility and safety have been shown. In addition to the above listed patient populations, which are in line with the intended use of the different Armeo medical devices, one study investigated the use of ArmeoSpring in burn victims, showing positive results and no additional contraindications [35].

3

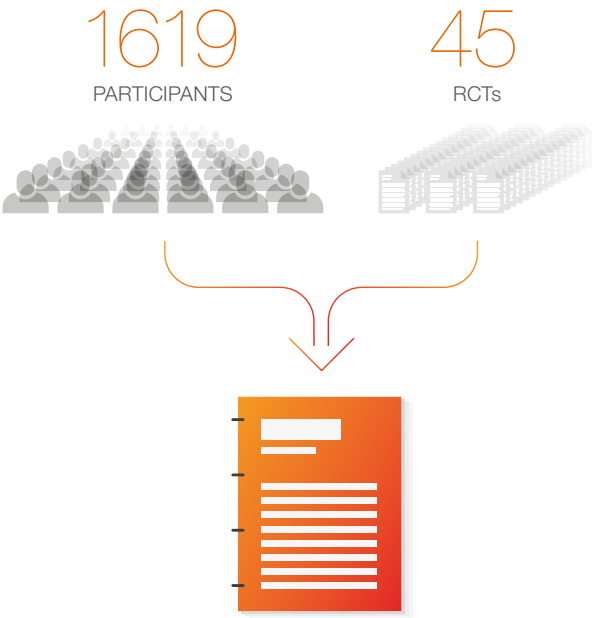
TECHNOLOGY-ASSISTED ARM TRAINING IMPROVES ACTIVITIES OF DAILY LIVING, ARM FUNCTION AND ARM STRENGTH

A high-quality evidence systematic review [36] shows that:

- The use of technological devices in rehabilitation settings improves activities of daily living, arm function and arm strength.
- Technology-assisted arm therapy after stroke is more effective than other interventions if the same time of practice is offered.

The authors believe that:

- Technology-assisted training can provide more repetitions per session compared to conventional therapy.
- Robotic training allows therapy with limited supervision, which increases training efficiency.
- Technology-assisted rehabilitation increases the motivation to train.



4

FIFTEEN RANDOMIZED CONTROLLED TRIALS REPORT POSITIVE RESULTS

The Armeo training results in improvements in the following domains:

- Quality of movement [3, 9]
- Arm function [1–3, 9, 20, 37–40]
- Muscle strength [4, 20, 40]
- Range of motion [1, 3, 9, 18, 25, 37]
- Pain and spasticity [4, 38]
- Activities of daily living [1, 3, 4, 6, 9, 18, 20, 37, 38, 40]
- Cognitive function [18]

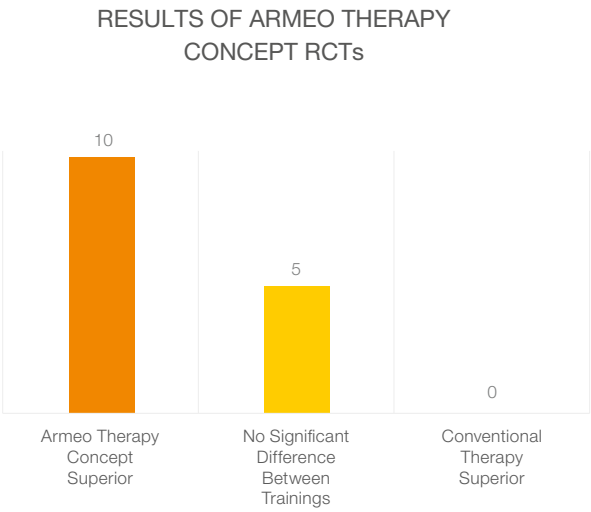


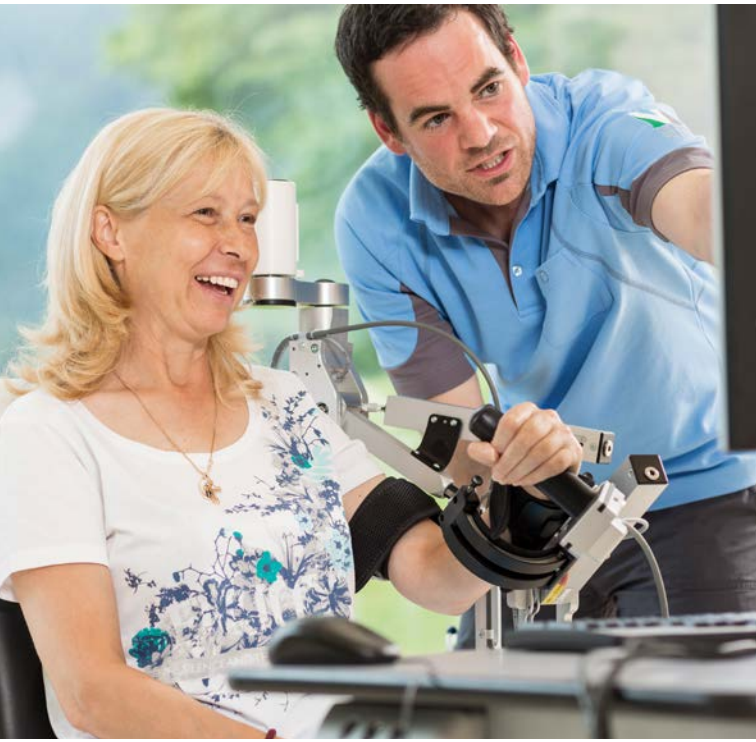
Figure 2: Most Randomized Controlled Trials (RCTs) comparing Armeo Therapy Concept training to conventional therapy show advantages for Armeo Therapy Concept.

5 THE ARM WEIGHT SUPPORT MAXIMIZES THE PATIENTS' MOTOR FUNCTIONS

Training with arm weight support helps developing movement ability also in non-weight-supported conditions which enhances the general gains in motor functions [9].

Individuals with chronic arm impairments post-stroke can relearn to control arm movement when given arm weight support through the Armeo devices [14].

Combining arm weight support with Augmented Performance Feedback has been shown to help severely affected patients improve performance in reach-to-grasp exercises [9, 41].



EFFECT OF ARM WEIGHT SUPPORT
ON PERFORMANCE

Figure 3: Example data from one stroke patient as she attempted to trace a circle 30 times, without arm weight support (GB) (top) and with arm weight support (bottom), using T-WREX (ArmeoSpring). © 2006 IEEE. Reprinted, with permission, from [14].

6 THE ARMEO THERAPY CONCEPT ALLOWS INCREASED TRAINING INTENSITY AND REPETITIONS

The intensity of the rehabilitation program is a key factor for recovery after neurological injury [42]. However, intensity is typically rather low during a conventional arm therapy session [43, 44].

The Armeo Therapy Concept provides more repetitions in the same therapy time [7, 20, 28], which leads to improved outcomes.

The number of extra therapy sessions provided through Armeo training is correlated with improvement in shoulder strength [5].

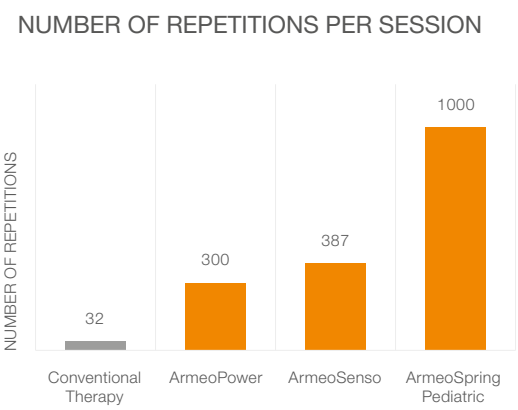


Figure 4: Average number of repetitions per training session with conventional therapy [44], training with ArmeoPower [20], with ArmeoSenso (without arm weight support) [7] and with ArmeoSpring Pediatric [28].

7

TRAINING WITH ARMEO DEVICES PROVIDES LONG-TERM BENEFITS

Armeo training not only improves motor functions, but also allows individuals to sustain these gains and to continue improving even up to 6 months after treatment [9, 22, 45], indicating long term benefits of the Armeo Therapy Concept.

CHANGE IN OUTCOME MEASURES DUE TO ARMEOSPRING AND CONVENTIONAL THERAPY

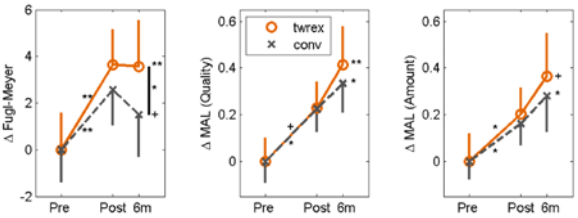
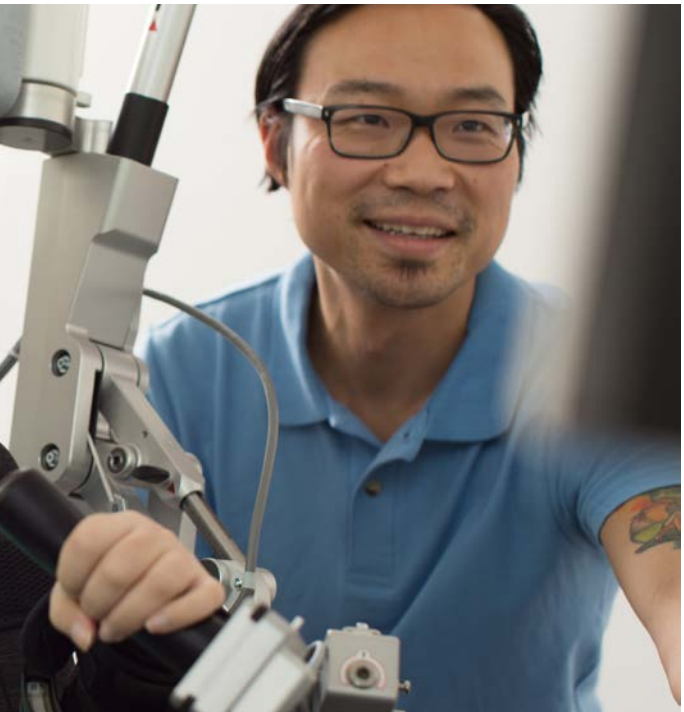


Figure 5: Change in Arm Motor Fugl-Meyer, Motor Activity Log (Quality of movement) and Motor Activity Log (Amount of use) scores at baseline (Pre), after 2 months of therapy (Post) and at 6-month follow-up (6m) [9]. Patients continue to improve after treatment with T-WREX (ArmeoSpring). © 2009 SAGE Publications Inc. Reprinted by Permission of SAGE Publications, Inc.



8 AUGMENTED PERFORMANCE FEEDBACK INCREASES MOTIVATION

Evidence shows that more repetitions of a rehabilitative activity improve effectiveness of treatment [46]. However, performing similar repetitive activities might lead to boredom [47] and consequently to a lack of adherence to the treatment.

Through the Augmented Performance Feedback offered by the Armeo Therapy Concept, it is possible to increase participation and motivation [33, 45, 47-49].

In a user satisfaction questionnaire about ArmeoSpring training, patients positively rated their experience with the device and they expressed the desire to continue training with it [5, 33, 48].

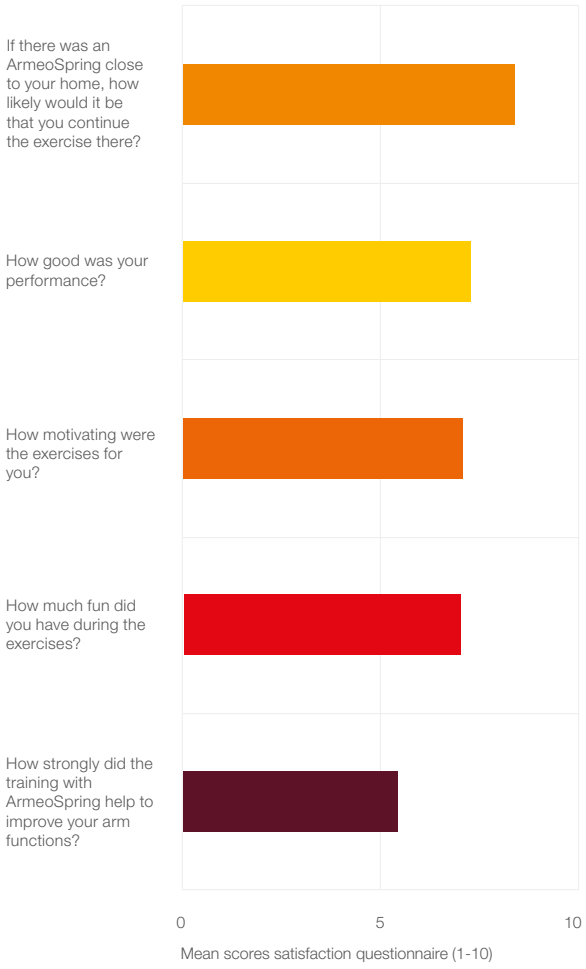


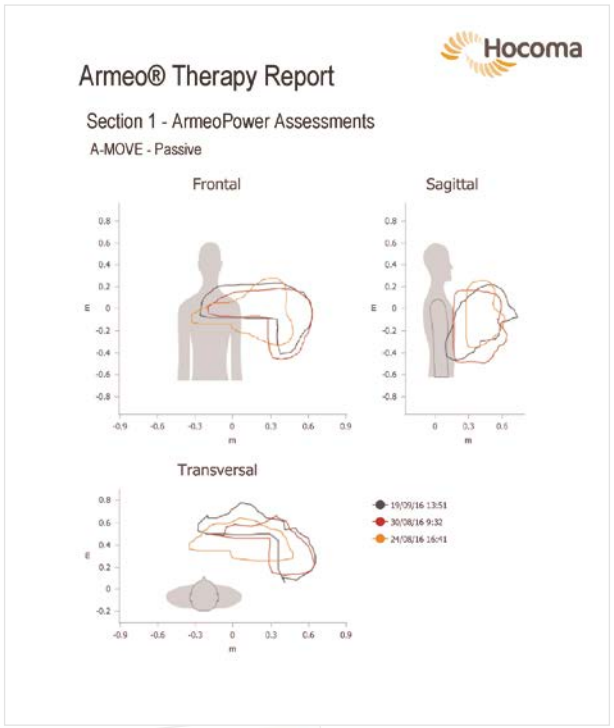
Figure 6: Mean scores of the user satisfaction questionnaire about ArmeoSpring training [5].

9

THE ARMEO THERAPY CONCEPT OFFERS OBJECTIVE ASSESSMENTS

Armeo assessments are tools to objectively track patients' performance and progress.

- ArmeoPower can be used to assess quality of movement, spasticity, isometric force and range of motion [50].
- ArmeoPower metrics (peak speed, smoothness and hand path curvature) are accurate and reliable [51].
- ManovoPower grip strength assessment is valid and reliable [52].
- ArmeoSpring can be used to assess quality of movement [13, 53, 54].
- ArmeoSpring parameters related to quality of movement, such as smoothness of the hand trajectories, are sensitive to changes in arm function over time [13].
- ArmeoSenso sensors provide valid and reliable data [55].


Hocoma
Armeo® Therapy Report
Section 1 - ArmeoPower Assessments
A-MOVE - Passive
Frontal
Sagittal
Transversal
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Hocoma
Armeo® Therapy Report
Section 1 - ArmeoPower Assessments
A-FORCE
Shoulder flexion torque
Horizontal shoulder adduction torque
Shoulder inner rotation torque
Elbow flexion torque
Pronation torque
Wrist flexion torque
Hand opening/closing torque
Armeo® Therapy Report
Section 1 - ArmeoPower Assessments
A-ROM - Passive
Shoulder flexion/extension
Horizontal shoulder ab-/adduction
Shoulder inner/outer rotation
Elbow flexion/extension
Forearm pronation/supination
Wrist flexion/extension
Hand opening/closing

10 THE ARMEO THERAPY CONCEPT COVERS THE CONTINUUM OF CARE

Research provides evidence for the Armeo Therapy Concept throughout all levels of motor impairment of the arm, thereby covering the continuum of arm and hand rehabilitation.

MMT: Manual Muscle Test for shoulder and/or elbow, *MMT 2 for ArmeoSenso = with arm weight support

The Armeo Therapy Concept includes three different devices, each one targeting different patient needs.

- ArmeoPower enables severely impaired individuals to perform goal-oriented tasks in a virtual and motivating environment [2]. Moreover, with ArmeoPower it is possible to adapt the exercise difficulty, avoiding frustration in the most severe individuals [41].
- ArmeoSpring provides arm weight support during training and it improves the performance of individuals with moderate impairment after an injury [4] or a neurological disorder [22], by amplifying the residual traces of movement [14].
- ArmeoSenso allows individuals with mild arm impairment to improve their strength and endurance [7].

Figure 7: The Armeo Therapy Concept covers the continuum of care, tailoring arm and hand rehabilitation to the patient's needs.

ArmeoPower

SUMMARY

- ArmeoPower is suitable for the most severely affected individuals
- ArmeoPower training leads to motor improvements
- Shoulder stability is improved during ArmeoPower training

ArmeoPower is suitable for the most severely affected individuals

Even the most severely affected individuals post-stroke benefit from ArmeoPower training, showing significant improvements in arm and hand function [2]. Moreover, the gains appear faster than they would with conventional therapy.

FUNCTIONAL CHANGES DUE TO ROBOTIC AND CONVENTIONAL THERAPY

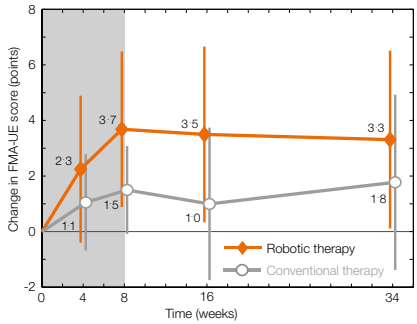

Figure 8: Changes in the Fugl-Meyer Assessment for Upper Extremity (FMA-UE) in severely affected individuals (FMA-UE<19 at baseline) with conventional and robotic training during therapy (16 weeks), at the end of the therapy period (34 weeks) and at follow-up (16 weeks) [2]. Reprinted by permission of the authors.

ArmeoPower training leads to motor improvements

- Increased motor function [2, 45]
- Improved smoothness and accuracy of movement [56]
- Reduced time to accomplish tasks [56]

Shoulder stability is improved during ArmeoPower training

Arm weight compensation provided by the ArmeoPower increases shoulder joint stability by reducing shear forces during tasks that simulate activities of daily living. ArmeoPower provides the opportunity to train isolated shoulder movements which may be useful in early rehabilitation in the presence of shoulder muscle weakness [57].

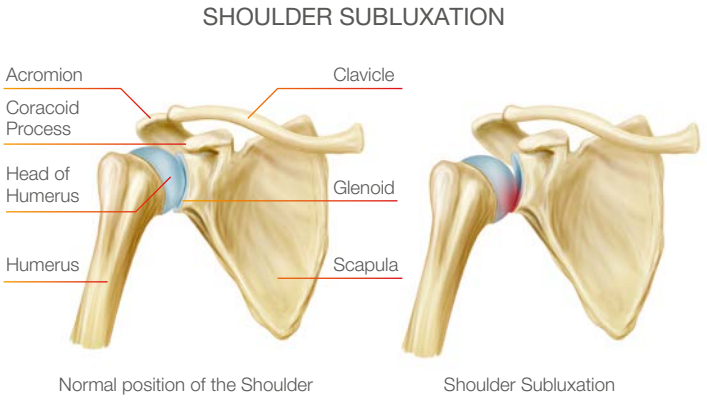

Figure 9: Patients after a neurological injury are at risk of shoulder subluxation. © 2019 RehabMyPatient.com. Reprinted by permission of RehabMyPatient.com

ArmeoSpring

SUMMARY

- ArmeoSpring training is safe and effective for different populations
- ArmeoSpring training leads to motor improvements
- ArmeoSpring training can be performed under limited supervision
- ArmeoSpring Pediatric is safe and effective in children

ArmeoSpring training is safe and effective for different populations

Neurological conditions, such as:

- Stroke [3-6, 9-15, 18]
- Multiple sclerosis [22, 23]
- Spinal cord injury [19, 21]
- Cerebral palsy [26-30, 58]
- Acquired brain injury [24-26]

Other pathologies:

- Burn victims [35]
- Individuals recovering from a humerus fracture [33]

ArmeoSpring training leads to motor improvements

ArmeoSpring training reduces motor impairments and leads to improvements in the following domains:

- Quality of movement [3, 9, 26]
- Arm function [3-5, 9, 39]
- Muscle strength [4, 5, 33]
- Range of motion [3, 9, 25, 33, 35, 59]
- Pain and spasticity [4, 38]
- Activities of daily living [3, 4, 6, 9, 15, 22, 27]

ArmeoSpring training can be performed under limited supervision

Training with ArmeoSpring in a clinical setting under limited supervision and minimal assistance is safe and feasible [5, 9, 48] and promotes independence [47].
Training with limited supervision gives the therapist the opportunity to provide therapy to more patients at the same time in a safe and efficient environment.

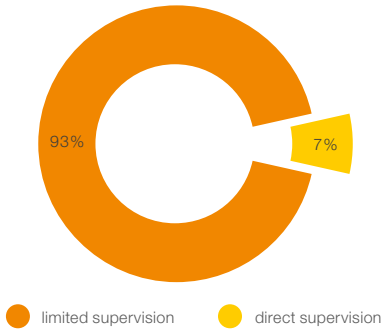

Figure 10: Breakdown of direct/limited supervision time in a 60-minute session with ArmeoSpring [9].

ArmeoSpring training with limited supervision is positively rated by patients and allows extra rehabilitation time. A correlation between the number of extra training sessions and the amount of shoulder force improvement was shown [5].

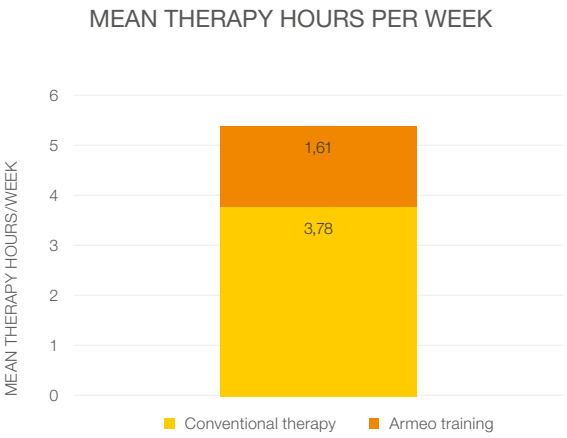

Figure 11: Mean therapy hours per week. Conventional therapy hours are complemented with Armeo training with limited supervision [5].

ArmeoSpring Pediatric is safe and effective for treating children

- ArmeoSpring Pediatric is safe and effective for treating children with acquired brain injury and cerebral palsy [24-29, 58].
- ArmeoSpring Pediatric training increases the movement efficiency and reduces the compensatory shoulder movements in children with acquired brain injury [24].
- ArmeoSpring Pediatric enables children with cerebral palsy to acquire arm and hand skills and transfer them to daily activities [28].
- ArmeoSpring Pediatric provides a fun, virtual environment which enhances adherence to treatment and retention of the relearned motor functions in children with cerebral palsy [28].

ArmeoSenso

SUMMARY

- ArmeoSenso training leads to motor improvements
- ArmeoSenso remote-supported home therapy is safe and feasible

ArmeoSenso training leads to motor improvements

- Improvement of arm function [7, 60]
- Reduction of compensatory trunk movements [7]
- Enhanced adherence to therapy [7, 60]
- Increase of workspace [7].

Figure 12: Bi-weekly average of number of voxels during 2D workspace assessment in the transverse plane [7]. Bars show the standard error of the mean. The workspace improved significantly by 31% between the first two weeks and the last two weeks ($p = 0.008$).

ArmeoSenso remote-supported home therapy is safe and feasible

ArmeoSenso can be used safely at home with remote supervision, after an initial education by a therapist [7].

11 THE HOCOMA KNOWLEDGE PLATFORM: FIND ALL AVAILABLE LITERATURE IN ONE PLACE!

A full overview of all papers published in peer-reviewed journals on the Armeo Therapy Concept devices can be found on the Hocoma Knowledge Platform (https://knowledge.hocoma.com/research/armeo.html).

New in Clinical Practice

November 12, 2018

Case Report: Using the ArmeoSpring in Upper Extremity Motor Recovery Following Stroke

We would like to share the clinical experience we had with a patient whom we'll call ZM. ZM had a stroke which resulted in a decreased quality of life.

When ZM was first admitted to King David Center she spent most of her time in her room. She lacked the motivation to participate in recreational activi- ties due to the severity of her limitations and over- all low self-esteem. ZM began participating in oc- cupational and physical rehabilitation to help re- gain her independence and increase her quality of life.

read more

0 Comments

Clinical Practice

New in Research

Electromechanical and Robot-Assisted Arm Training for Improving Activities of Daily Living, Arm Function, and Arm Muscle Strength after Stroke

Mehrholz, J., M. Pohl, T. Platz, J. Kugler, and B. Elsner

Publication: Cochrane Database

Year: 2018

Research

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The publications included in this document take into consideration the commercial and research versions of the devices, such as ARMin, T-WREX, HandSOME and ArmeoSenso.
The described characteristics are not necessarily applicable to all the Armeo Therapy Concept devices. Check the specific device sections for the unique features of each device.

CURRENT HOCOMA RESEARCH FOCUS:
Hocoma would like to thank all their research partners and the many researchers who independently showed interest and studied our devices for their hard work and dedication. Together, we're pushing the field forward and improving therapy for our patients!
Hocoma, along with our partners, is currently focused on the following research topics:

- How can I increase the efficiency and show the economic advantages of delivering therapy with Hocoma devices? We join forces with clinical partners with experience in research who are interested in collaborating with health economists on this topic.

- The Armeo Therapy Concept targets the continuum of care. How can we best treat patients with different levels of motor function to target specific therapy goals? We look for clinical partners with experience in research interested in determining evidence-based guidelines and treatment plans including our technology.

- Valid and reliable assessments are extremely important to provide tailored therapy and motivation to the patient. We look for collaborations with clinical and engineering researchers to develop novel metrics which can be used during robot-assisted therapy to measure improvements.

If you have clinical expertise and a good idea on how to highlight the clinical potential of our devices in a research project, please find the Hocoma Collaboration Request Form here:
https://www.hocoma.com/services/clinical-research/ !

If you have engineering expertise and want to contribute to the technical innovation of our devices, please contact us at info@hocoma.com with the keyword "Technical innovation" in the subject line.

INTENSITY = REPETITION × EFFORT

This is what drives us at Hocoma: a strong motivation to help people with technologies and ideas that look at functional movement therapy from a **completely new perspective**. Because these technologies enable people to exercise **intensively**. Because they maximize **motivation**. Because they encourage patients to make possible what they've been told was impossible.

We improve the lives of millions by providing functional and efficient solutions that set new standards in the field of human movement therapy.

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