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International Scientific and Training Meeting: Robotics and Modern Forms of Education in Medical Professions September 3rd, 2025, Kraków, Poland

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Conference reports

About the Meeting

We are presenting abstracts from the presentations from the international conference held in Krakow on September 3, 2025. The proceedings were divided into two thematic Sessions: 1: Modern Technologies in the Service of Precision and Prevention, and 2: Education, Communication, and Personalizing Innovation.

The first session of the conference opened the world of medicine, where advanced technology is becoming an integral element of patient care, from prevention to complex surgical interventions. The session began with a reflection on robot-assisted surgery in gynecology and general surgery, which, thanks to 3D visualization and exceptional precision, is redefining the standards of minimally invasive surgery. However, it is important to emphasize that this technology must be paired with proactive disease prevention, which is the foundation of modern care. This section also explores artificial intelligence and machine learning, which are revolutionizing obstetric and neonatal care through early risk stratification and clinical decision support in intensive care units. A breakthrough in neurorehabilitation was also presented, where systems

Keywords

- medical professions
- modern forms of education
- robotics
- medicine
- conference
- abstracts

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based on the principles of neuroplasticity and brain-computer interfaces are opening up new possibilities for patients' recovery. An important point about education rounded out the discussion: high-fidelity medical simulation allows for the development of technical competences, while also reminding them that robots cannot replace empathy, and that the heart of medicine remains the human relationship.

In the second session, the focus shifted to the process of developing medical staff and adapting innovations to individual patient needs. The discussion began with the question of how to educate a master surgeon who combines theoretical knowledge with courage and critical thinking, treating recommendations as guideposts rather than rigid algorithms. An important element of modern education, also addressed during this session, was intercultural communication, which is becoming an indispensable tool in the hands of physiotherapists working in diverse social environments. This session also provided a forum for presenting specific technological solutions, such as innovative weight-bearing support systems (BWS) and telemedicine applications based on artificial neural networks that automate the selection of orthopedic equipment. The issue of identifying technological gaps in exoskeleton design was also addressed, in order to create modular solutions better tailored to patient needs. It demonstrated how modern vision and VR systems can support home rehabilitation and how urban architecture can promote mobility. The session concluded with a presentation on the role of simulation laboratories as a foundation for preparing health sciences students for the challenges of real-world clinical work.

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Session 1: Modern Technologies in the Service of Precision and Prevention

Robot-assisted surgery in gynecologic oncology and urogynecology — and why modern medicine begins with prevention

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Introduction: Robot-assisted surgery represents an important step forward in gynecologic oncology and urogynecology, offering greater precision, reduced invasiveness, and faster recovery. However, true modernity in patient care begins much earlier – with effective prevention. In gynecologic oncology, preventive measures such as HPV vaccination, regular screening, and early detection of precancerous changes are crucial. In urogynecology, prevention includes patient education on pelvic floor exercises, lifestyle modification, and early intervention at the first signs of dysfunction. Advanced surgical technologies, including robotics, should be viewed as part of a comprehensive care pathway in which the operative stage is a last resort rather than the first choice.

Conclusions: Integrating prevention with advanced diagnostics and minimally invasive surgery not only improves treatment outcomes but also reduces the number of necessary interventions. This approach requires interdisciplinary collaboration, patient education, and a paradigm shift – from reacting to disease toward proactively preventing its onset.

Keywords: robotics in gynecologic oncology, robotics in urogynecology, prevention, diagnostics

Artificial intelligence in midwifery care

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Introduction: Maternal health risks remain a critical challenge worldwide, contributing substantially to maternal and infant morbidity and mortality, especially in the most vulnerable populations. In the modern era, with recent progress in artificial intelligence and machine learning, strong promise has emerged for early risk detection and its management.
Objective: This research aims to classify maternal health risk (low, mid, high) using machine learning algorithms based on physiological data.
Materials and methods: The dataset contains 1,014 instances (i.e., cases) with seven attributes (i.e., variables): Age, SystolicBP, DiastolicBP, BS, BodyTemp, HeartRate, and RiskLevel. The pre-processed dataset was then used to train and test six classifiers with 10-fold cross-validation. Finally, model performance was compared using metrics such as Accuracy, Precision, and the True Positive (TP) Rate.
Results: The best performance was achieved by the Random Forest, which reached the highest values for Accuracy (88.03%), TP Rate (88%), and Precision (88.10%), demonstrating robustness in maternal health risk classification. The mid-risk category was the most challenging across all models, characterized by lower Recall and Precision scores, underscoring class imbalance as a performance bottleneck.
Conclusions: Machine learning algorithms hold strong potential for improving maternal health risk prediction. The findings underline the role of machine learning in advancing maternal healthcare by driving more personalized approaches.

Keywords: artificial intelligence, machine learning, maternal health, risk stratification, physiological data, Random Forest, class imbalance

Artificial intelligence in neonatology

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Introduction: Artificial intelligence (AI) is permeating society and will transform healthcare. As neonatologists, we must understand AI concepts to integrate these tools safely and effectively. We present an overview of AI applications in neonatology and neonatal intensive care unit (NICU) care, along with reflections on the future. First, we define key concepts such as machine learning (ML) and deep learning. We then discuss challenges and ethical considerations related to developing and implementing AI in the NICU. Next, we review how AI may improve diagnosis, treatment, and prediction of outcomes in neonatology. Finally, we outline directions for further integrating AI into clinical practice.
Conclusions: Although AI and multi-omic approaches hold substantial potential for advancing NICU care management and research, further refinement is necessary to ensure content validity and address safety concerns, thereby enabling integration of AI into clinical workflows and safeguarding data privacy.

Keywords: artificial intelligence, machine learning, deep learning, neonatology, NICU, clinical decision support, multi-omics

The use of high-fidelity simulation in the management of shoulder dystocia at childbirth: The 5-year experience of the simulation center in the Department of Midwifery od the University of Western Macedonia in Greece

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Introduction: The Simulation Center of the Midwifery Department at the University of Western Macedonia, Greece, has over five years of experience delivering cutting-edge, high-fidelity, simulation-based training.
Objective: To showcase the Center's work in training for the management of shoulder dystocia and its broader educational and societal impact.
Materials and methods: EU-funded projects conducted within doctoral and postdoctoral research and implementation frameworks were used to provide high-fidelity simulation training for midwifery students and practicing midwives.

Results: More than 200 participants – including midwifery students and practicing midwives – were trained in the management of shoulder dystocia.
Conclusions: This work has helped transform the department into a leading academic and research hub, significantly shaping students' professional development, advancing the academic field, and generating tangible societal impact at both regional and national levels.

Keywords: high-fidelity simulation, shoulder dystocia, midwifery education, obstetric emergency, simulation-based training, professional development

Device-based systems in neurological rehabilitation

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Introduction: Rehabilitation is a key component of care for individuals with functional impairment and reduced activity. Recent years have seen rapid advances in bioengineering and device-based solutions that enable optimal stimulation, activate learning processes, and help restore lost functions. Medicine and neurorehabilitation are undergoing an era of change due to the exponential development of artificial intelligence and the increasing presence of robotics in rehabilitation practice. Nevertheless, the therapist–patient relationship remains central to care, and standardized rehabilitation techniques continue to underpin many treatment methods. The aim of this presentation is to summarize, based on a narrative review, research findings on the effectiveness and outcomes of rehabilitation using modern device-based systems for gait re-education and hand function in patients with signs of central nervous system injury. We will also present our own experience with gait-assist robots and the results of research aimed at developing a device to support restoration of upper-limb function using a brain–computer interface.
Conclusions: Findings from numerous studies indicate that robot-assisted rehabilitation, virtual reality, and computer games – combined with physiotherapy – can yield tangible benefits for people with neurological disorders. Brain–computer interface–based solutions represent a new direction in neurorehabilitation that may be used routinely to replace or restore function in individuals with severe disabilities resulting from neuromuscular disorders.

Keywords: neurological rehabilitation, advanced devices, gait re-education, hand function re-education

Robot-assisted procedures in general and oncologic surgery

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Introduction: Robotics is a key element of modern minimally invasive surgery, increasing precision, safety, and patient comfort while improving surgeon ergonomics. Robotic systems combine surgeon-controlled instrumentation with high-resolution 3D visualization, facilitating procedures in challenging anatomical conditions.
Applications: In general surgery, robots enable operations on most abdominal organs with reduced perioperative tissue trauma, less blood loss, shorter hospital stays, and faster recovery compared with laparotomy. In oncologic surgery, they facilitate precise resections and better access to deeply located lesions, which may reduce complications.
Challenges and prospects: Key barriers include acquisition and maintenance costs and the need for specialized training. Future directions include integration with artificial intelligence and augmented reality, further automation, and decision-support systems.
Conclusions: In general, and oncologic surgery, robotic techniques reduce procedural trauma, shorten hospitalization, and may improve clinical outcomes. Broad implementation, however, requires financial and educational investment.
Keywords: robotic surgery, general surgery, oncologic surgery, minimally invasive surgery, artificial intelligence, augmented reality

A robot does not teach empathy — medical simulation as a balance between technology and humanity

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Introduction: This paper presents the advantages and disadvantages of training in a simulation center. Why don't robots and manikins teach empathy on their own?

Effective clinical education requires a balance between technology and the human element. High-fidelity simulators enhance safety, repeatability, and technical competence, preparing teams for rare, critical situations. However, they do not reproduce authentic emotions or complex communication. Therefore, hybrid scenarios that combine manikins with standardized patients, together with structured debriefing that fosters reflection, empathy, and collaboration, are essential. We place particular emphasis on interprofessional team training, clear role delineation, and closed-loop communication.
Conclusions: For simulations focused on technical modules, we recommend adding an actor component, planning emotion-focused questions for debriefing, jointly formulating technical and communication goals, and assessing empathy with standardized instruments. The goal is a professional who combines procedural proficiency with attentiveness to the patient.

Keywords: simulation center-based education, high-fidelity simulators

Neuroplasticity-robotic rehabilitation: From concept to clinical practice

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Introduction: Neuroplasticity, the brain's intrinsic ability to reorganize neural pathways in response to injury, training, or environmental changes, has become a cornerstone concept in modern neurorehabilitation. Advances in robotic technologies now provide unique opportunities to harness this potential by enabling highly intensive, repetitive, and task-specific training that is otherwise difficult to achieve through conventional therapies. Robotic rehabilitation systems not only support motor recovery by facilitating precise and measurable movements but also create interactive environments that stimulate sensory and cognitive processes, thereby reinforcing neuroplastic mechanisms. This lecture will review the theoretical foundations linking neuroplasticity with robotic-assisted rehabilitation and present clinical evidence from stroke, spinal cord injury, and other neurological conditions. Particular emphasis will be placed on translating experimental findings into everyday clinical practice, including patient selection, therapy protocols, and outcome evaluation. Furthermore, practical challenges such as cost, accessibility, and integration into multidisciplinary care will be discussed.
Conclusions: By bridging the gap between concept and clinical application, robotic rehabilitation represents a paradigm shift in neurorehabilitation – offering patients new possibilities for functional recovery and autonomy. The session will aim to highlight not only current best practices but also future directions for innovation in this rapidly evolving field.

Keywords: neuroplasticity, robotic rehabilitation, task-specific training, stroke, spinal cord injury, motor recovery, multidisciplinary care

Application of robotic techniques in neurosurgery: Past, present, future

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Introduction: In an era of rapidly evolving medical technologies, robotics and innovative operative techniques are playing an increasingly important role in everyday clinical practice. The authors present how modern technologies – including surgical robots, medical simulators, virtual and augmented reality (VR/AR), and artificial intelligence – affect the quality and efficiency of care for patients with neurosurgical conditions. Robotics is one of the most dynamically developing areas of neurosurgery. The use of surgical robots such as ROSA and Stealth Autoguide enables procedures – including stereotactic interventions (brain tumor biopsies, implantation of electrodes for deep brain stimulation) and spinal stabilization – to be performed with exceptional precision.
Conclusions: The application of robotic techniques in neurosurgery opens new possibilities for the surgical treatment of neurological disorders, therapy personalization, and surgeon education through VR simulations and decision-support systems. It also significantly shortens the duration of the aforementioned procedures and increases their safety.

Keywords: medical simulators, virtual and augmented reality (VR/AR), artificial intelligence in neurosurgery

Innovative technologies in teaching at a medical university

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Introduction: The author presents innovative tools designed using 3D modelling and interaction in virtual reality. VR tools cover the following areas: surgery; triage with the air ambulance service; a chemistry laboratory; anatomy; eye diseases and defects; a medical Escape Room; anesthesiology; and vascular access and puncture procedures. Tools in a 3D environment include a 3D Birth Atlas and 3D Anatomical Specimens (using AI). AI-based tools include a virtual visual AI bot based on LLM-RAG models, a chest X-ray assistant, and an AI Bot – Simulated Patient.
Conclusions: Innovative tools, virtual reality, and AI are being applied in medical professions in both patient care and the education of students.

Keywords: virtual reality, AI

Collaboration and the role of the physiotherapist in an interdisciplinary team developing robotic devices for physiotherapy

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Introduction: The dynamic development of robotic technologies creates new opportunities in patient rehabilitation; however, the effectiveness and safety of such solutions depend on close interdisciplinary collaboration. At the center of this process is the physiotherapist – a specialist who not only uses the equipment in therapy but also actively participates in its design and refinement. The physiotherapist contributes clinical knowledge about patients' needs and limitations, identifies critical aspects of ergonomics, safety, and functionality, and serves as a "translator" between the patient and the engineer. The presentation discusses the author's experience – as a physiotherapist and academic teacher at the Medical University of Silesia in Katowice – as a co-creator of the SIDRA LEG and MEISA projects (EGZO TECH, Gliwice), illustrating the practical importance of physiotherapist involvement in constructing robotic equipment. The educational perspective will also be addressed – the need to prepare physiotherapy students to work in interdisciplinary teams using modern technologies such as robotics, artificial intelligence, and virtual reality. It will be emphasized that the physiotherapist of the future will not be merely a user of tools but a co-creator and driver of innovative therapy.
Conclusions: The author underscores the role of the interdisciplinary team – and the physiotherapist within it – who actively participates in the treatment process and serves as a creator of robotics-based therapy.

Keywords: interdisciplinary team, robotic equipment, artificial intelligence, VR

Use of robots in post-stroke rehabilitation

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Introduction: Electromyography (EMG)–controlled robotic training is a modern, innovative form of neurorehabilitation for post-stroke patients. Active patient participation promotes greater activation of the sensorimotor network compared with passive movement.
Objective: To present study results and the authors' clinical experience with the use of a rehabilitation robot in therapy for post-stroke patients.
Materials and methods: Study 1 – Limanowa (Poland): Sixty subacute post-stroke patients were randomized to an intervention group (IG, robot training) or a control group (CG, exercises on a rotor [pedal exerciser]). In addition to standard rehabilitation, both groups performed one extra daily session for 6 weeks. Outcomes included the Timed Up and Go (TUG) test, the Modified Ashworth Scale, knee range of motion, muscle strength (Lovett scale), and thigh circumference. Study 2 – Brest (France): Five patients (40–75 years) with chronic hemiparesis completed a 6-week program (2 baseline weeks; 2 weeks with LUNA EMG + conventional rehabilitation; 2 weeks with conventional rehabilitation only). Outcomes included movement smoothness (SPARC), motor control (Fugl–Meyer), function (ARAT, Box and Block), grip strength, spasticity, pain, and fatigue.

Clinical experience – multiple centers: Five post-stroke patients underwent varied training with the LUNA EMG device, including EMG-triggered movement and EMG biofeedback. Interventions targeted the shoulder, knee, foot, hand, and facial muscles.
Results: Study 1: Both rehabilitation protocols produced significant improvement in all analyzed parameters. The robotic group showed a more pronounced reduction in spasticity and a greater increase in thigh circumference. Study 2: LUNA EMG use was safe and beneficial. Most patients improved in movement smoothness and motor control; the largest effects were seen in those retaining partial function. The robot proved at least as effective as conventional physiotherapy and can complement it.
Clinical experience: Patients exhibited pain reduction, increased muscle coordination, functional gains, and good training tolerability.
Conclusions: Incorporating an EMG-controlled neurorehabilitation robot into post-stroke therapy favorably influences spasticity reduction, movement control, and selected functional parameters. Clinical experience confirms the potential for broad application of the robot in treating diverse post-stroke deficits – from lower-limb control and shoulder/hand rehabilitation to facilitating facial muscle training.

Keywords: rehabilitation robot, spasticity, EMG-triggered movement, LUNA EMG, stroke

Session 2: Education, Communication, and Personalizing Innovation

How to train a surgeon

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Introduction: The presentation "How to Train a Surgeon?" is a reflection on the process of surgical training in Poland. The author argues that surgical mastery requires not only broad theoretical and practical knowledge but also character traits: patience, courage, and critical thinking. Particular emphasis is placed on craftsmanship, continuity in the transfer of knowledge, and the need for individual interpretation and critical appraisal of medical recommendations – guidelines are signposts, not operating algorithms.
Conclusions: Drawing on military analogies, the author illustrates a multilevel approach to treatment, from the tactical, through the operational, to the strategic, highlighting the role of planning and the ability to adapt to unpredictable clinical situations.

Keywords: surgical education, surgical practice guidelines

Intercultural communication in physiotherapy practice in the MOV-e Project

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Introduction: Working as a physical therapist requires continuous training and improvement of practical skills, as well as effective and respectful communication with people who have different value systems, resulting, for example, from various cultural backgrounds. It seems that the latter aspect is not sufficiently emphasized in academic education. To fill this gap and respond to student demand, a project called Development of Intercultural Communication Skills in Physiotherapy Practice through an E-learning Course on Movement Analysis and Therapy with the acronym MOV-E was created.
Objective: The project aimed to create a free platform, available in several languages, enabling simultaneous improvement of soft skills and training in the diagnosis and therapy of movement in patients of different ages and with different special needs.

Methods: To create the course (1) the methodology of a culture sensitive online course developing knowledge, communication skills and professional competences in movement analysis and therapy was prepared: a review of the literature, familiarization with physiotherapy study programs in partner countries, gathering the opinions and needs of students and practitioners; (2) he topics of individual lessons were selected and their scenarios were developed; (3) video materials were recorded; (4) an e-learning platform was created; (5) a self-study manual was prepared. At each stage of the work, its results were subjected to internal and external evaluation.
Results: Based on the opinions of students, academics, and practitioners, 15 lessons were created, each of which combines learning how to diagnose and treat a specific musculoskeletal dysfunction in a patient with special communication needs. Care was taken to ensure that the patients were of different ages. Sample lessons cover (1) gender-sensitive communication in assessing infant motor development; (2) therapy for a painful shoulder in a blind person; (3) gait analysis in a person whose beliefs require them to cover their body. The lessons are supplemented with numerous graphics and approximately 200 video recordings.
Conclusions: Partners from Finland, Spain, Malta, Turkey, Hungary, and Poland have prepared a course consisting of 15 online lessons and a self-study manual, completing and extending the content of the lessons. The course ends with a final test and the award of a personal certificate. The project's recipients are primarily physiotherapy students and practicing physiotherapists, but also other people interested in kinesitherapy and increasing interpersonal skills in an intercultural community (https://mov-e.education/).

Keywords: interpersonal communication, culturally diverse environment, therapeutic team, movement analysis, movement therapy, holistic physiotherapy

Students' opinions on the use of modern technologies in developing intercultural communication skills: The case of the MOV-e Project

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Introduction: The aim of this presentation is to present the opinions of physiotherapy students regarding the course developed as part of the MOV-e project. The respondents participated in a pilot edition of the course based on e-learning and blended-learning methods. An analysis of the survey results and participants' reflections indicates that digital technologies support the development of intercultural competencies, especially in terms of interaction, openness, and adaptation to diverse cultural contexts. At the same time, students pointed out certain limitations, including the need for adequate technical and pedagogical preparation of teachers and ensuring equal access to technological resources.
Summary: The research results confirm that modern technologies can play an important role in developing intercultural communication, provided they are consciously and methodically integrated into the teaching process.

Keywords: modern technologies, teaching, online education

Innovative system for dynamic body-weight support rehabilitation: Scientific and clinical foundations of the project

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Introduction: Body Weight Support (BWS) and its variations are effective in improving gait and stability in individuals with motor disabilities, including post-stroke, spinal cord injury, cerebral palsy, and neurodegenerative diseases. Recent literature highlights that combining BWS therapy with progress-monitoring technologies – such as electromyography (EMG) and vision-based motion analysis – enhances personalization, enables precise biomechanical assessment, and accelerates functional recovery.
Objective: To identify clinical indications and scientific support for integrating EMG and vision-based monitoring into an innovative dynamic BWS rehabilitation system for individuals with motor impairments. The project aims to develop a device and dedicated sensor–software suite enabling real-time progress tracking, supported by a research and development center.

Methods: A literature review was conducted in PubMed, Cochrane Library, and Web of Science for 2020–2025, focusing on randomized controlled trials, meta-analyses, and systematic reviews. At least three high-quality systematic reviews and multiple studies on EMG and vision-based monitoring in rehabilitation were identified.
Results: Evidence supports BWS in improving locomotor parameters, balance, and pain reduction. Integration of EMG and vision systems was shown to enhance assessment precision and support adaptive therapy protocols.
Conclusions: BWS rehabilitation offers significant clinical benefits across diverse patient groups. The proposed system has the potential to integrate advanced biomechanical and informatics technologies, enabling real-time monitoring, personalized therapy, and optimized rehabilitation outcomes.

Keywords: body weight support rehabilitation, suspended system, therapy progress, monitoring system, randomized controlled trials, meta-analyses, systematic reviews

Analysis and support of physiotherapy using advanced vision systems and artificial intelligence models

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Introduction: Advances in vision systems and artificial intelligence (AI) enable the development of new tools supporting physiotherapy and individual training, especially in out-of-hospital and home-based settings.
Objectives: The aim of the research was to develop solutions using AI and image analysis to monitor exercise quality, evaluate therapy progress, and automatically generate recommendations supporting rehabilitation and training processes.
Material and methods: Within the conducted research and development work, a mobile system analyzing smartphone camera data and a web-based panel for doctors and physiotherapists were created, enabling the analysis of medical documentation and patient results. Data from clinical sessions and home-based exercises were integrated and analyzed using expert rules and AI algorithms.
Results: The developed solutions allow monitoring exercise correctness, detecting movement irregularities, motivating patients to exercise regularly, and adjusting therapy to individual needs.
Conclusions: Modern vision systems and AI can significantly improve the effectiveness and accessibility of physiotherapy by providing better control over the rehabilitation process and supporting specialists in therapeutic decision-making.

Keywords: physiotherapy, artificial intelligence, vision systems, home rehabilitation, motion analysis

Identifying technological gaps as the foundation for designing modern robotic rehabilitation systems

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Introduction: Robotic rehabilitation devices, particularly wearable exoskeletons, have shown promising results in supporting gait training for individuals with motor impairments. However, current solutions often fall short in terms of adaptability, user comfort, and integration of advanced control systems. Recent advances in artificial intelligence, especially Artificial Neural Networks (ANN) and reinforcement learning (RL), offer opportunities to address these shortcomings through real-time, personalized adaptation of gait parameters based on multimodal sensory feedback, including balance control systems.
Objective: To identify technological gaps in existing robotic rehabilitation systems that can inform the development of an innovative AI-based rehabilitation device capable of optimizing gait patterns and maintaining balance in real time.
Methods: A literature review was conducted in PubMed, Cochrane Library, and Web of Science for 2020–2025, focusing on randomized controlled trials, systematic reviews, and meta-analyses. The review highlighted both clinical findings and technological limitations, revealing specific design areas for innovation.

Results: Four major technological gaps were identified: 1) Device weight and size reduction 2) Modular design – enabling adaptation to the user's functional capacity and specific limitations, 3) Improved balance control, 4) AI-driven stability enhancement – leveraging ANN and interfaces for real-time neural signal processing and personalized therapy protocols through reinforcement learning. Additionally, the lack of exoskeleton solutions tailored to pediatric or smaller-stature users was identified as a significant innovation opportunity.
Conclusion: Bridging these technological gaps through lightweight, modular, AI-driven exoskeletons with integrated real-time balance control has the potential to redefine robotic rehabilitation. Access to pre-trained neural models and global collaboration could accelerate development, standardize evaluation, and bring patient-centered, adaptive rehabilitation closer to clinical reality

Keywords: robotic rehabilitation, exoskeletons, artificial neural networks, balance control, technological gaps, reinforcement learning

Application of artificial neural networks in the selection of orthopedic equipment

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Introduction: The growing needs of people with mobility disabilities require modern, personalized technological solutions. Current wheelchair selection processes are time-consuming and imprecise. The aim of the project is to develop a telemedicine application based on artificial neural networks (ANN) that will automate the measurement, selection, and personalization of wheelchairs, support rehabilitation, and improve patients' quality of life.
Material and methods: The project includes building a biomechanical model, integrating data from sensors and 3D scanners, applying ANN to analyze movement parameters, and creating an intuitive interface for users and specialists. Real-world data/evidence (RWD/RWE) will be collected and analyzed in real time.
Results: To date, the work has resulted in a prototype measurement device and preliminary ANN algorithms that increase personalization precision. The solution will enable rapid wheelchair selection, reduce the number of specialist visits, improve patient comfort, and lower system costs.
Conclusions: The project will introduce an innovative telemedicine system to support rehabilitation, increasing the accessibility, effectiveness, and safety of personalized wheelchairs. The solution will help reduce barriers in the daily functioning of people with mobility disabilities.

Keywords: telemedicine applications, device personalization, rehabilitation

Effectiveness of robot-assisted interventions in improving function in patients undergoing orthopedic rehabilitation: A literature review

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Introduction: Robot-assisted rehabilitation is gaining increasing importance in the treatment of orthopedic patients after surgery and traumatic injuries. The aim of this review was to determine the effectiveness of therapies using robotic devices in improving motor function in adult patients undergoing orthopedic rehabilitation. Six studies were included: three randomized clinical trials, two systematic reviews/meta-analyses, and one narrative review. The interventions analyzed involved, among others, the knee, radiocarpal (wrist), hip, and ankle joints, using various devices (e.g., WRISTBOT, Hunova®, Hybrid Assistive Limb, exoskeletons).
Conclusions: In most studies, statistically significant improvements were observed in range of motion, muscle strength, gait, balance, and functioning in daily life. One study also reported shortened hospital stays and reduced treatment costs. Additional benefits included increased patient engagement and greater repeatability of exercises. Despite these positive results, limitations included small sample sizes, heterogeneous therapeutic protocols, and a lack of long-term follow-up. Further high-quality studies are needed to optimize the use of robotic technologies in everyday clinical practice.

Keywords: robotic interventions in rehabilitation

Functional facial physiotherapy supported by information technology

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Introduction: The concept of the Mirror For Face Therapy (M4FTh) system arose from the reported difficulty in accessing professional rehabilitation for patients with diseases involving facial dysfunction – primarily orthognathic and oncologic patients, those with genetic defects or neurological conditions, and patients undergoing reconstructive, plastic, or aesthetic treatment. A patient diagnosed with such a condition may use the system during preoperative preparation or during specialist rehabilitation after surgery or another intervention, as well as following pharmacological treatment. Once qualified for the M4FTh protocol, the patient is instructed by a licensed physician or physiotherapist on how to use the system and then performs the prescribed exercises and therapeutic activities based on information about how to perform them, therapy frequency, therapy duration, number of repetitions, and movement amplitude (range). The system also allows monitoring of scars, edema, and wounds.
Implementation: The M4FTh system is based on image analysis using pose estimation. Integration with an external storage array is planned; through a coordination center, both the patient and the treating physician, physiotherapist, speech therapist, phoniatrist, etc., will have access. At home, images will be acquired using mobile devices (smartphone, tablet) or cameras integrated with a computer.
Conclusions: Patient benefits will include guidance on the types of exercises delivered by a virtual therapist and reports on treatment progress. In addition, the system will allow sending concerning information with a request for teleconsultation, enabling prompt referral for an in-person visit when needed. Benefits for the medical team will derive from systematic monitoring of the patient's engagement in planned therapy sessions; qualitative and quantitative evaluation of sessions relative to prescribed tasks; and generation of reports between direct contacts with the patient. The attending physician and physiotherapist will be able to monitor adherence and, if necessary, contact the patient. An extended version of the system may include a treatment monitoring lab established at a hospital or research unit, providing remote oversight of individual patients with the option to connect with a specialist.

Keywords: facial physiotherapy, information technology

Shape care physio as a tool supporting rehabilitation of patients after traumatic brain injury

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Introduction: Comprehensive therapy for patients after neurological and neurosurgical incidents is increasingly supported by technologies that improve physiotherapist ergonomics and enable ongoing reporting of rehabilitation progress using quantitative data. Visual motion analysis performed in real time – or retrospectively from archived audiovisual documentation – can provide additional information that meaningfully guides modulation of the rehabilitation course. Human-pose detection in the ShapeCare Physio application relies on computer-vision techniques: pose-estimation models take a processed camera image as input and output key-point information indexed with a confidence score from 0.0 to 1.0. The application is an innovative, mobile tool operated on a smartphone. The authors present case analyses of selected patients using traditional therapy, robotic rehabilitation, and therapy with the LeviActive system, with outcomes assessed by traditional methods as well as by vision-based analysis.
Conclusions: Modern solutions used in physiotherapy clearly support the treatment process and positively influence functional outcomes.

Keywords: machine learning models, computer-vision analysis, neurorehabilitation

Impact of virtual reality--based rehabilitation devices on upper limb function in post-stroke patients

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Introduction: With technological advances, rehabilitation for post-stroke patients is being enhanced with modern tools that not only support therapy but also enable objective assessment of patient progress. Methods based on biofeedback aim to restore lost or impaired sensory information necessary for proper motor planning. The aim of this study was to evaluate the effectiveness of virtual reality (VR)–based rehabilitation in improving upper-limb function in post-stroke patients. Materials and Methods: The study included 25 post-stroke patients who underwent a 3-week rehabilitation program using the ESOGLOVE upper-limb therapy device employing VR. The study was conducted in the Neurological Rehabilitation Department of the Prof. Bogusław Frańczuk Małopolska Orthopedic and Rehabilitation Hospital in Kraków. The following assessment tools were used: the Barthel Index, the Rivermead Motor Assessment (RMA), and an author-designed questionnaire.
Results: The results showed that VR-based therapy significantly contributed to improved upper-limb function in post-stroke patients. A substantial increase in the RMA-3 score (by an average of 21.2 points), assessing hand function, confirmed that VR supports the development of precise movements such as grasping objects, writing, and hand manipulation. Particularly good outcomes were observed among individuals who began rehabilitation within the first three months after the stroke. In the RMA-1 test, assessing global functions and basic motor skills (e.g., sitting, standing up, walking), improvement was observed, with a mean difference of 28.4 points. A statistically significant improvement was noted in performance of activities of daily living according to the Barthel Index, by an average of 25.4 points. Data analysis indicates that patient age may influence VR therapy effects on hand function, whereas sex and comorbidities did not show a significant impact.
Conclusions: The findings confirm the effectiveness of VR as a modern and efficient tool supporting motor rehabilitation of the upper limb in post-stroke patients. VR therapy not only accelerates recovery of function but also positively affects independence and quality of life.

Keywords: virtual reality, stroke, neurorehabilitation, Barthel Index, RMA scale

The impact of arthroplasty and postoperative rehabilitation on static foot-loading parameters, balance, and functional status in patients with advanced knee osteoarthritis

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Introduction: Osteoarthritis, including knee osteoarthritis, is becoming increasingly common worldwide each year. It leads to loss of independence, reduced quality of life, and even premature death. Knee osteoarthritis (KOA) also often increases the risk of falls, causes improper distribution of body weight across the lower limbs, and worsens gait quality.
Objective: To assess the impact of knee arthroplasty and postoperative rehabilitation on static foot-loading parameters, balance, and patients' functional status.
Materials and methods: The study included 30 patients (25 women, 5 men) over 60 years of age who underwent total knee arthroplasty (TKA) followed by 4–6 weeks of postoperative rehabilitation in the inpatient unit of the Prof. Bogusław Frańczuk Małopolska Orthopedic and Rehabilitation Hospital in Kraków. The following tools were used: an author-designed questionnaire to characterize the study group; the KOOS (Knee Injury and Osteoarthritis Outcome Score); the Functional Reach Test (FRT); and the Timed Up and Go (TUG) test. The final component was measurement of ground reaction force distribution using a Zebris FDM (Force Distribution Measurement) platform, compared with results reported by other authors. A statistical analysis of the results was performed.
Results: The study group had a mean age of 70.7 years; BMI ranged from 18.8 to 40.2 kg/m^2. Only 17% of

participants had a BMI within the normal range; 30% were overweight, and 23% had moderate obesity. Increased risk of falls measured by the FRT was observed in 7% of participants, while the TUG indicated increased fall risk in 33% of patients. Greater loading of the operated lower limb was observed (53.33%). Assessment of center-of-pressure distribution showed greater hindfoot loading (61.83%) compared with the forefoot (38.17%). KOOS results were as follows: Pain (83.37 to 74.10), Activities of Daily Living (87.12 to 72.50), and Quality of Life (56.68 to 50.90).
Conclusions: There was a difference in the distribution of loading forces between the study groups: patients after total knee arthroplasty loaded the operated limb more than the healthy limb, whereas individuals in the control group loaded the healthy limb more. No statistically significant differences were observed in the center-of-pressure shift between groups. A difference in functional status measured by the KOOS was also noted between groups. Patients after TKA and postoperative rehabilitation presented a low risk of falls as measured by the TUG and FRT.

Keywords: total knee arthroplasty, knee osteoarthritis

Designing urban spaces as environments for maintaining functional capacity — using simulation, VR, and AI-based image generators at the faculty of architecture, Cracow University of Technology

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Introduction: The authors present a teaching approach for undergraduate architecture students in the courses Design of Single-Family Housing Complexes and Interior Design. In the fourth semester, students design a residential complex with shared spaces, taking into account the needs of diverse user groups, including the promotion of healthy lifestyles and the maintenance of functional capacity. The interior design course focuses on shared spaces that integrate people with diverse abilities and cultural backgrounds. The classes begin with a universal design module – hands-on workshops using orthopedic equipment and the GERT aging simulator. This is complemented by an Accessibility Testbed created by the Sustainable Design Student Research Group, which enables the simulation of movement across various surfaces, as well as VR presentations of good practices in urban design. A new AI module, piloted within the Erasmus+ AInterior initiative, employs tools such as Stable Diffusion (text-to-image) and VizCom (image-to-image) to visualize interiors and outdoor spaces. The program concludes with a second universal design module dedicated to dimensioning spaces for different users.
Conclusions: In designing spaces that integrate people with diverse abilities and cultural backgrounds, simulation techniques, VR, and AI-based image generators are employed.

Keywords: design of single-family housing complexes, interior design, cultural differences, VR, AI

From theory to practice: The use of simulation labs to strengthen skills in health sciences students at the University of Almeria

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Introduction: Simulation labs offer a controlled and safe environment for students to practice, make mistakes, and learn from them without risk to real patients.
Aim: To present the importance of clinical simulation and the key benefits of implementing and actively using this teaching resource at the University of Almería (UAL).
Materials and methods: Include simulation in the curriculum design of the Faculty of Health Sciences as part of student training. Investment in state-of-the-art equipment; faculty training is emphasized so instructors can design scenarios and provide quality feedback. The lab serves as a tool for assessing competencies and for promoting interdisciplinary collaboration among students from different health areas.
Results: For students: development of technical skills and clinical reasoning. In addition, they will improve their non-technical skills (communication, leadership) and learn to manage stress and pressure. For patients: students can make mistakes and learn from them in a controlled environment, without real-life

consequences. For UAL: optimization of resources and a repeatable practice environment.
Conclusion: Simulation is a fundamental pillar in the training of healthcare professionals, ensuring excellence and preparing them with the knowledge, practical skills, and resilience needed for the real working world.
Keywords: simulation-based education, high-fidelity simulation, health sciences students, clinical skills, curriculum integration, interdisciplinary collaboration, competency assessment

The use of heart rate variability in the rehabilitation treatment of vertebropathy

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Introduction: Manual therapy is a method that therapeutically addresses blockages to restore balance, i.e., by intervening in a given segment. Neural therapy involves removing sources of irritation, i.e., interference fields, which can be located anywhere in the body. Its therapeutic effect can be verified by assessing heart rate variability (HRV).
Material and methods: This case study concerns a 21-year-old patient with vertigo and fluctuating hypo- and hypertension. A thorough history and a palpation examination were performed to identify the corresponding segmental zone and trigger points. The functional finding consisted of pelvic nutation and a blockage in the C1–C2 segment. Assuming a vasovagal disorder, HRV was measured before and after treatment using the VarCor 7 device. Physiotherapy consisted of kinesiotherapy focused on diaphragmatic breathing training and a set of exercises according to the Mojžišová method.
Results: Assessment of the patient's dysfunction using HRV before the examination and after the therapeutic intervention shows that the changes in the vertebropathy are permanent.
Conclusion: Neural therapy is based on a thorough history, palpation examination, and the administration of a local anesthetic into the center of irritation. Measuring HRV before and after the procedure evaluates not only dysregulation of cardiac activity but also pathological changes in the autonomic nervous system.

Keywords: heart rate variability, neural therapy, manual therapy, vertebropathy, kinesiotherapy, diaphragmatic breathing, autonomic nervous system

Extremiter: Compression--vacuum therapy and robotic devices in upper and lower limb rehabilitation

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Introduction: The authors present the use of innovative medical devices in physiotherapy. Extremiter is a device for compression–vacuum therapy that operates by alternately generating subatmospheric (negative) and positive pressure. Cyclical pressure changes improve peripheral perfusion and support tissue healing. It is used in rehabilitation, including for venous insufficiency, lymphedema, Sudeck syndrome (complex regional pain syndrome), and in diabetology for patients with diabetic peripheral neuropathy, diabetic foot ulcers, and trophic skin changes. R-Force is an antigravity treadmill that enables gait training with up to 100% body-weight support (unweighting), allowing gait therapy to begin at a very early stage of rehabilitation. The technology reduces musculoskeletal loading. R-Force is used in orthopedic rehabilitation – after traumatic injuries and planned surgical procedures – as well as in neurological patients for gait re-education. It is also used for strengthening training in older adults and in sports. R-Touch is a soft-robotics technology used in upper-limb rehabilitation. Robotic gloves generate finger flexion and extension movements and also enable mirror therapy and cognitive training for patients after stroke.
Conclusions: The use of modern robotic devices offers an attractive and effective form of rehabilitation, even in the early period.

Keywords: robotic devices, physiotherapy