28th Annual Gabor Racz Advanced Interventional Pain Conference and Workshop
Budapest, Hungary August 25-27, 2025

Predictive Power: AI-Guided Outcome Forecasting in Spinal Cord Stimulation for Chronic Pain

Giuliano Lo Bianco, MD, PhD, FIPP, EDPM
Head of Analgesia & Percutaneous Surgery Unit
Fondazione G. Giglio, Cefalù, Italy

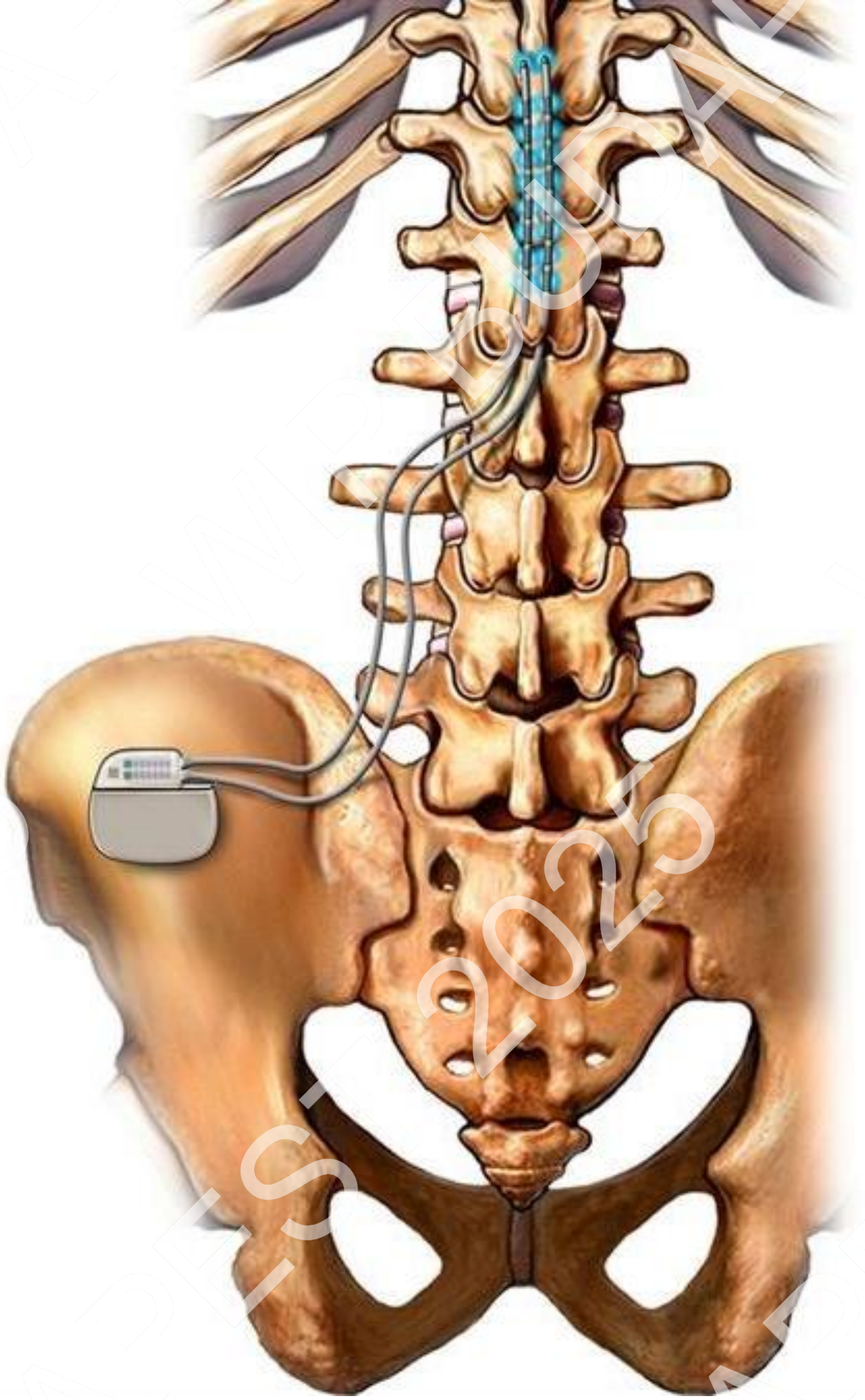
Conflicts of Interest

Speaker for:

-Abbott

-Promedica Europe

Fondazione Istituto
G. Giglio di Cefalù



Introduction

- SCS is a well-established therapy in chronic pain management.
- **Evidence:** SCS provides significant long-term pain relief, with *number needed to treat (NNT) between 1.2 and 2*, far superior to conventional medical management (NNT 4-10).
- Beyond pain reduction, SCS also reduces **opioid consumption**.
- Importance of accurate **patient selection**.
- Emerging role of **Artificial Intelligence** in outcome prediction.

Why Predictive Models Matter

- Variability in SCS outcomes: responder vs. non-responder rates.

- Economic & clinical implications of failed implants.

A failed implant is not just a missed opportunity ; it also carries costs, risks, and patient disappointment.

- AI as a decision-support tool.

Previous Work

- Demonstrated strong reliability & comprehensibility in patient education.
- Highlighted AI's limits in technical queries.

Journal of Clinical Medicine MDPI

Article

Reliability, Accuracy, and Comprehensibility of AI-Based Responses to Common Patient Questions Regarding Spinal Cord Stimulation

Giuliano Lo Bianco [1], Marco Cascella [2,*], Sean Li [3], Miles Day [4], Leonardo Kapural [5], Christopher L. Robinson [6,*] and Emanuele Sinagra [7]

1 Anesthesiology and Pain Department, Foundation G. Giglio Cefalù, 90015 Palermo, Italy; giulianolobianco@gmail.com
2 Anesthesia and Pain Medicine, Department of Medicine, Surgery and Dentistry "Scuola Medica Salernitana", University of Salerno, 84081 Baronissi, Italy
3 National Spine and Pain Centers, Shrewsbury, NJ 07702, USA; sli@treatingpain.com
4 Department of Anesthesiology, Texas Tech University Health Sciences Center, Lubbock, TX 79430, USA; miles.day@ttuhsc.edu
5 Carolinas Pain Institute, Winston-Salem, NC 27103, USA; lkapuralmd@gmail.com
6 Anesthesiology, Perioperative, and Pain Medicine, Harvard Medical School, Brigham and Women's Hospital, Boston, MA 02115, USA
7 Gastroenterology and Endoscopy Unit, Fondazione Istituto San Raffaele Giglio, 90015 Cefalù, Italy; emanuelesinagra83@googlemail.com
* Correspondence: mcascella@unisa.it (M.C.); crobinson48@bwh.harvard.edu (C.L.R.)

Abstract: Background: Although spinal cord stimulation (SCS) is an effective treatment for managing chronic pain, many patients have understandable questions and concerns regarding this therapy. Artificial intelligence (AI) has shown promise in delivering patient education in healthcare. This study evaluates the reliability, accuracy, and comprehensibility of ChatGPT's responses to common patient inquiries about SCS. **Methods:** Thirteen commonly asked questions regarding SCS were selected based on the authors' clinical experience managing chronic pain patients and a targeted review of patient education materials and relevant medical literature. The questions were prioritized based on their frequency in patient consultations, relevance to decision-making about SCS, and the complexity of the information typically required to comprehensively address the questions. These questions spanned three domains: pre-procedural, intra-procedural, and post-procedural concerns. Responses were generated using GPT-4.0 with the prompt "*If you were a physician, how would you answer a patient asking...*". Responses were independently assessed by 10 pain physicians and two non-healthcare professionals using a Likert scale for reliability (1–6 points), accuracy (1–3 points), and comprehensibility (1–3 points). **Results:** ChatGPT's responses demonstrated strong reliability (5.1 ± 0.7) and comprehensibility (2.8 ± 0.2), with 92% and 98% of responses, respectively, meeting or exceeding our predefined thresholds. Accuracy was 2.7 ± 0.3, with 95% of responses rated sufficiently accurate. General queries, such as "*What is spinal cord stimulation?*" and "*What are the risks and benefits?*", received higher scores compared to technical questions like "*What are the different types of waveforms used in SCS?*". **Conclusions:** ChatGPT can be implemented as a supplementary tool for patient education, particularly in addressing general and procedural queries about SCS. However, the AI's performance was less robust in addressing highly technical or nuanced questions.

Keywords: spinal cord stimulation; ChatGPT; artificial intelligence; patient education; chronic pain management; neuromodulation; healthcare communication

check for updates

Academic Editor: Hideaki Nakajima

Received: 15 January 2025
Revised: 6 February 2025
Accepted: 19 February 2025
Published: 21 February 2025

Citation: Lo Bianco, G.; Cascella, M.; Li, S.; Day, M.; Kapural, L.; Robinson, C.L.; Sinagra, E. Reliability, Accuracy, and Comprehensibility of AI-Based Responses to Common Patient Questions Regarding Spinal Cord Stimulation. *J. Clin. Med.* **2025**, *14*, 1453. https://doi.org/10.3390/jcm14051453

Previous Work

- Showed AI's capability to standardize and scale patient information delivery.
- Lessons applied to neuromodulation field.

biomedicines MDPI

Article

Effectiveness of Generative Artificial Intelligence-Driven Responses to Patient Concerns in Long-Term Opioid Therapy: Cross-Model Assessment

Giuliano Lo Bianco [1,*], Christopher L. Robinson [2], Francesco Paolo D'Angelo [3], Marco Cascella [4], Silvia Natoli [5,6], Emanuele Sinagra [7], Sebastiano Mercadante [8] and Filippo Drago [9]

1 Anesthesiology and Pain Department, Foundation G. Giglio Cefalù, 90015 Palermo, Italy
2 Anesthesiology, Perioperative, and Pain Medicine, Brigham and Women's Hospital, Harvard Medical School, Harvard University, Boston, MA 02115, USA; crobinson48@bwh.harvard.edu
3 Department of Anaesthesia, Intensive Care and Emergency, University Hospital Policlinico Paolo Giaccone, 90127 Palermo, Italy; francescods.dangelo@gmail.com
4 Anesthesia and Pain Medicine, Department of Medicine, Surgery and Dentistry "Scuola Medica Salernitana", University of Salerno, 84081 Baronissi, Italy; mcascella@unisa.it
5 Department of Clinical-Surgical, Diagnostic and Pediatric Sciences, University of Pavia, 27100 Pavia, Italy; silvia.natoli@unipv.it
6 Pain Unit, Fondazione IRCCS Policlinico San Matteo, 27100 Pavia, Italy
7 Gastroenterology and Endoscopy Unit, Fondazione Istituto San Raffaele Giglio, 90015 Cefalù, Italy; emanuelesinagra83@googlemail.com
8 Main Regional Center for Pain Relief and Supportive/Palliative Care, La Maddalena Cancer Center, Via San Lorenzo 312, 90146 Palermo, Italy; terapiadeldolore@lamaddalenanet.it
9 Department of Biomedical and Biotechnological Sciences, University of Catania, 95124 Catania, Italy; fdrago@unict.it
* Correspondence: giulianolobianco@gmail.com

Abstract: Background: While long-term opioid therapy is a widely utilized strategy for managing chronic pain, many patients have understandable questions and concerns regarding its safety, efficacy, and potential for dependency and addiction. Providing clear, accurate, and reliable information is essential for fostering patient understanding and acceptance. Generative artificial intelligence (AI) applications offer interesting avenues for delivering patient education in healthcare. This study evaluates the reliability, accuracy, and comprehensibility of ChatGPT's responses to common patient inquiries about opioid long-term therapy. **Methods:** An expert panel selected thirteen frequently asked questions regarding long-term opioid therapy based on the authors' clinical experience in managing chronic pain patients and a targeted review of patient education materials. Questions were prioritized based on prevalence in patient consultations, relevance to treatment decision-making, and the complexity of information typically required to address them comprehensively. We assessed comprehensibility by implementing the multimodal generative AI Copilot (Microsoft 365 Copilot Chat). Spanning three domains—pre-therapy, during therapy, and post-therapy—each question was submitted to GPT-4.0 with the prompt "*If you were a physician, how would you answer a patient asking...*". Ten pain physicians and two non-healthcare professionals independently assessed the responses using a Likert scale to rate reliability (1–6 points), accuracy (1–3 points), and comprehensibility (1–3 points). **Results:** Overall, ChatGPT's responses demonstrated high reliability (5.2 ± 0.6) and good comprehensibility (2.8 ± 0.2), with most answers meeting or exceeding predefined thresholds. Accuracy was moderate (2.7 ± 0.3), with lower performance on more technical topics like opioid tolerance and dependency management. **Conclusions:** While AI applications exhibit significant potential as a supplementary tool for patient education on opioid long-term therapy, limitations in addressing highly technical or context-specific queries underscore the need for ongoing refinement and domain-specific training. Integrating AI systems

check for updates

Academic Editors: Daniel Humberto Pozza and Isaura Tavares

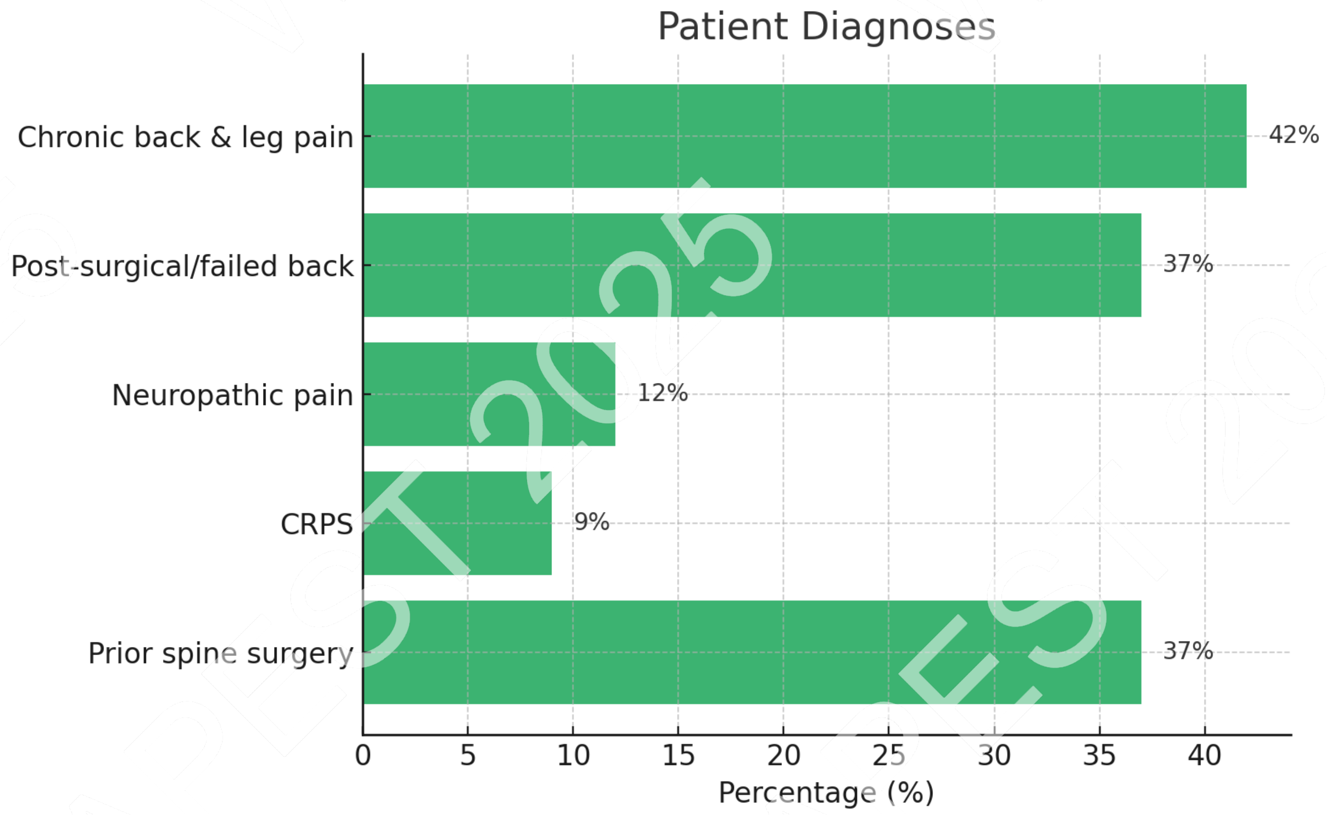
Received: 14 February 2025
Revised: 28 February 2025
Accepted: 4 March 2025
Published: 5 March 2025

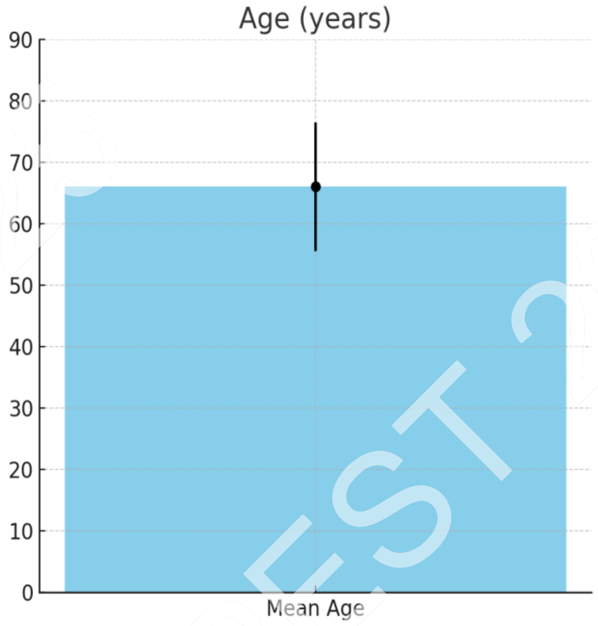
Citation: Lo Bianco, G.; Robinson, C.L.; D'Angelo, F.P.; Cascella, M.; Natoli, S.; Sinagra, E.; Mercadante, S.; Drago, F. Effectiveness of Generative Artificial Intelligence-Driven Responses to Patient Concerns in Long-Term Opioid Therapy: Cross-Model Assessment. *Biomedicines* **2025**, *13*, 636. https://doi.org/10.3390/biomedicines13030636

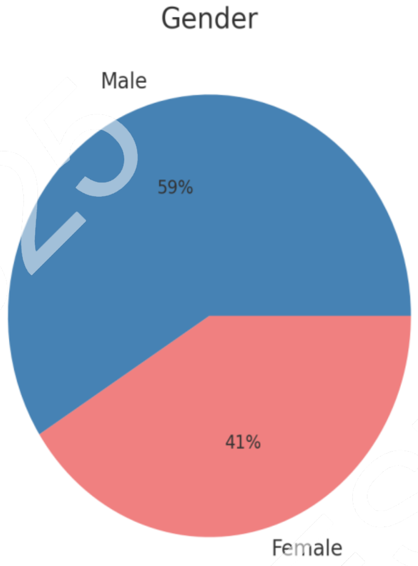
Overview

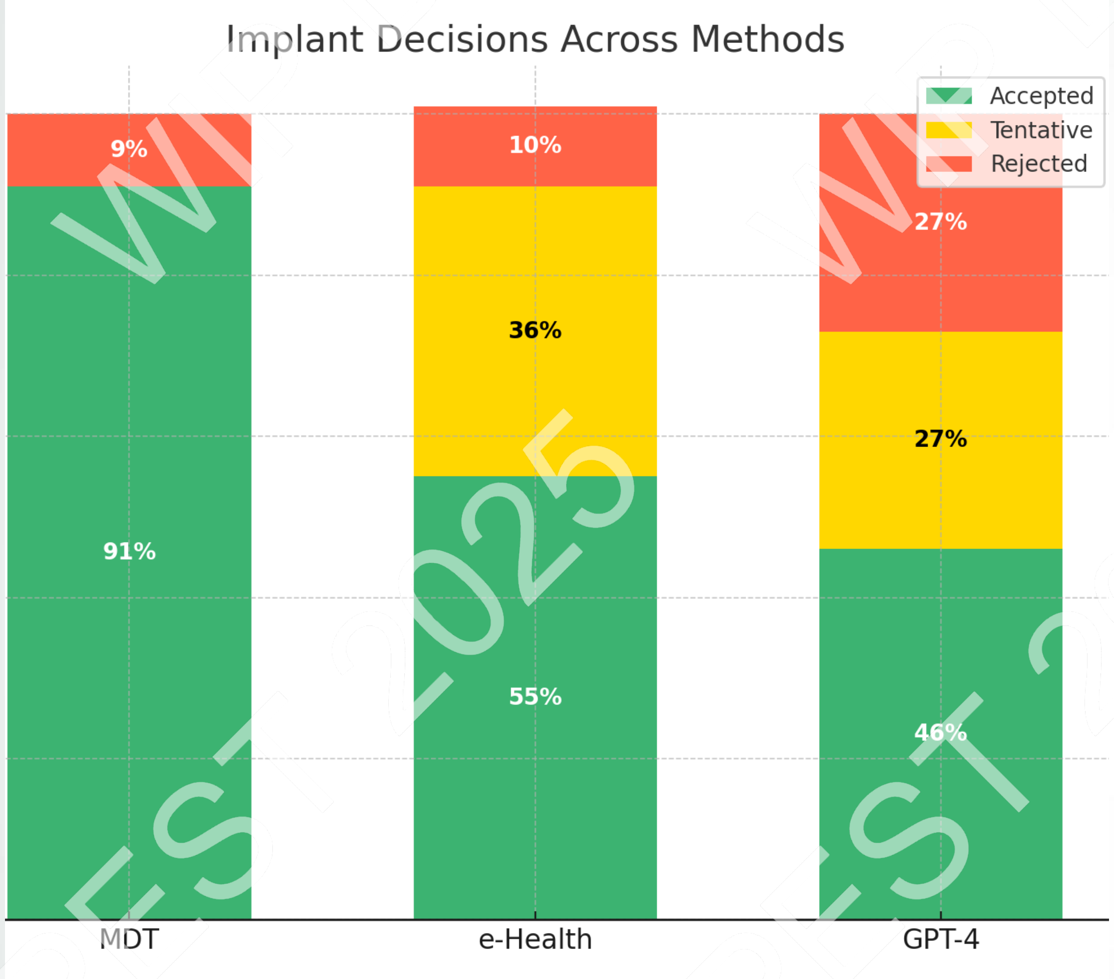
Smart Processing and Intelligent Navigation for Evaluation (SPINE) Study: A Comparative Decision-Making Analysis Evaluating Clinicians against Artificial Intelligence for Spinal Cord Stimulation Therapy

- Aim: Compare AI predictions, e-Health tools, and multidisciplinary team (MDT) decisions for SCS candidacy.









Methods

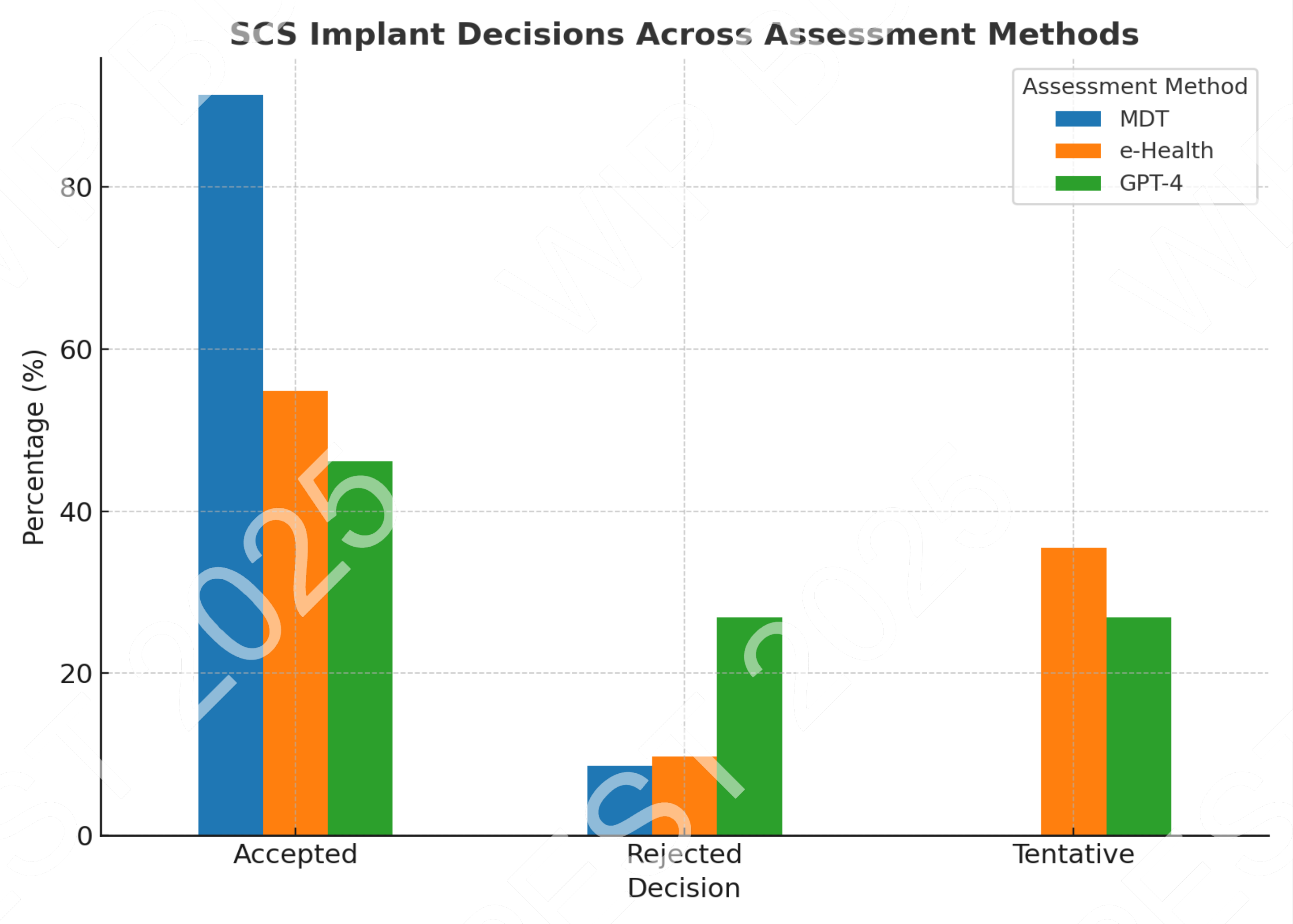
- Single-center conducted at Fondazione G. Giglio, Italy
- Patient dataset from Fondazione G. Giglio.

Each patient underwent:

- Three independent assessments: MDT, e-Health platform, GPT-4.
- Outcomes: acceptance, rejection, tentative trial.

Decision Comparison

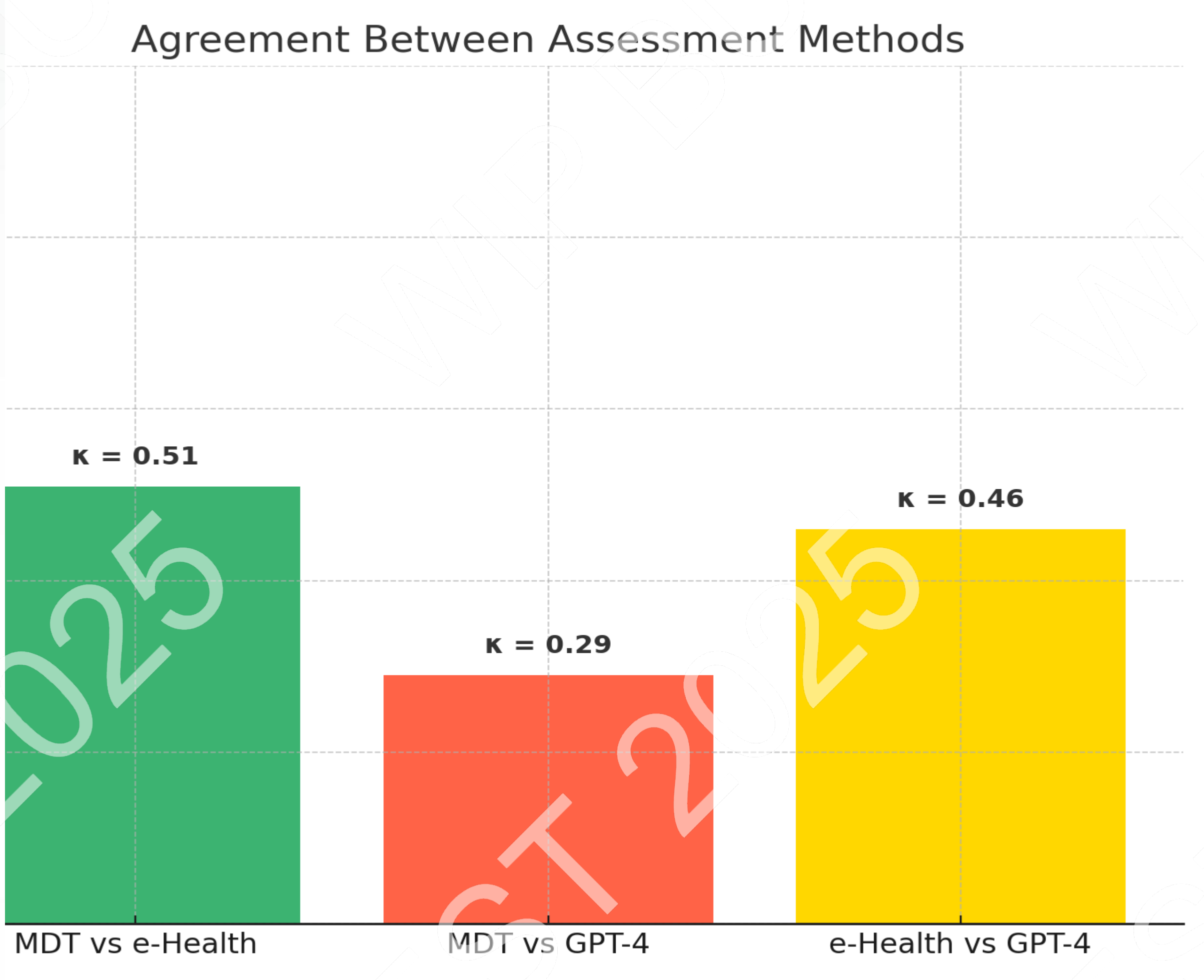
- MDT: Acceptance 91.4%
- e-Health: Acceptance 54.8%
- GPT-4: Acceptance 46.2%
- Observations on AI conservativeness.



Interestingly, GPT-4 was more conservative in its decisions, with a higher rejection rate.

Agreement Analysis

- MDT vs. e-Health: 0.51 (Moderate)
- MDT vs. GPT-4: 0.29 (Fair)
- e-Health vs. GPT-4: 0.46 (Moderate).

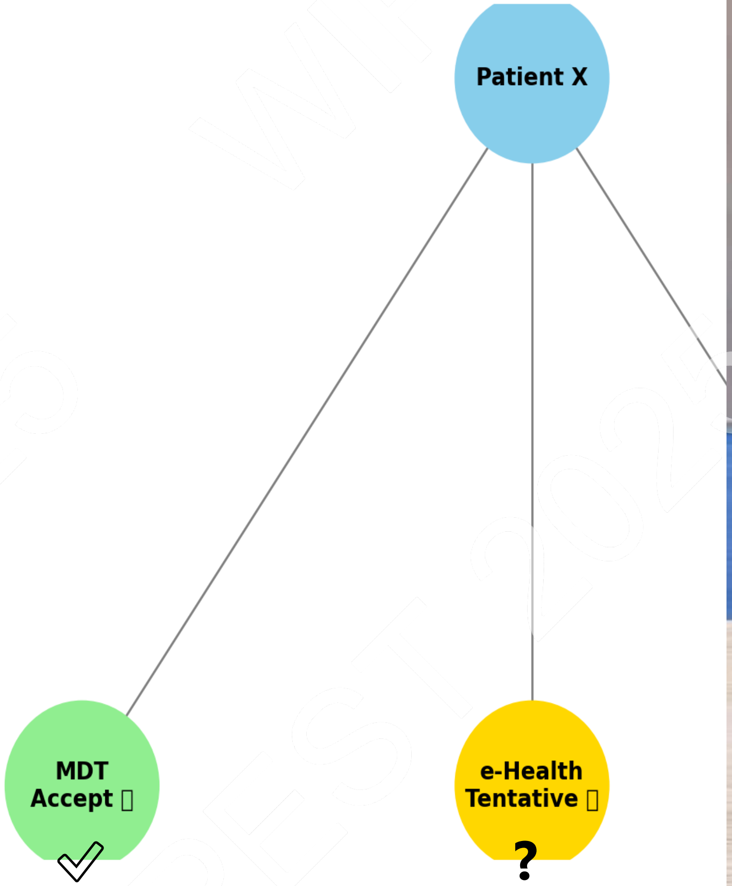


This tells us that AI is not yet ready to replace expert consensus, but can still be useful in certain decision-making stages.

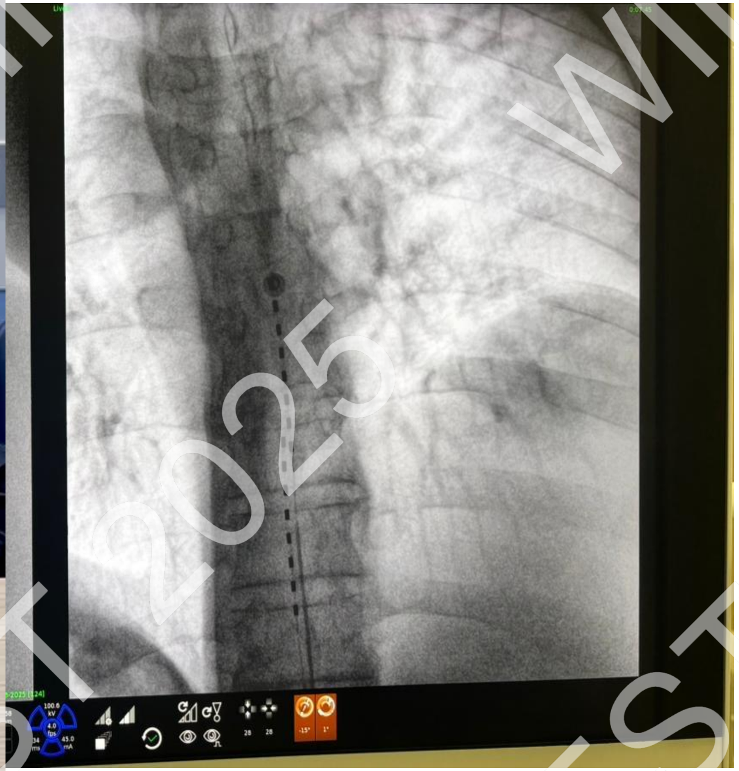
Example Ca

compare decision paths of MDT, e-Health, and GPT-4.

Example Case – Divergent De



2 patient with
n after L4–L5
lso presenting
upper limb pain
depression
surgery.



Diagnostic Accuracy Compared to MDT

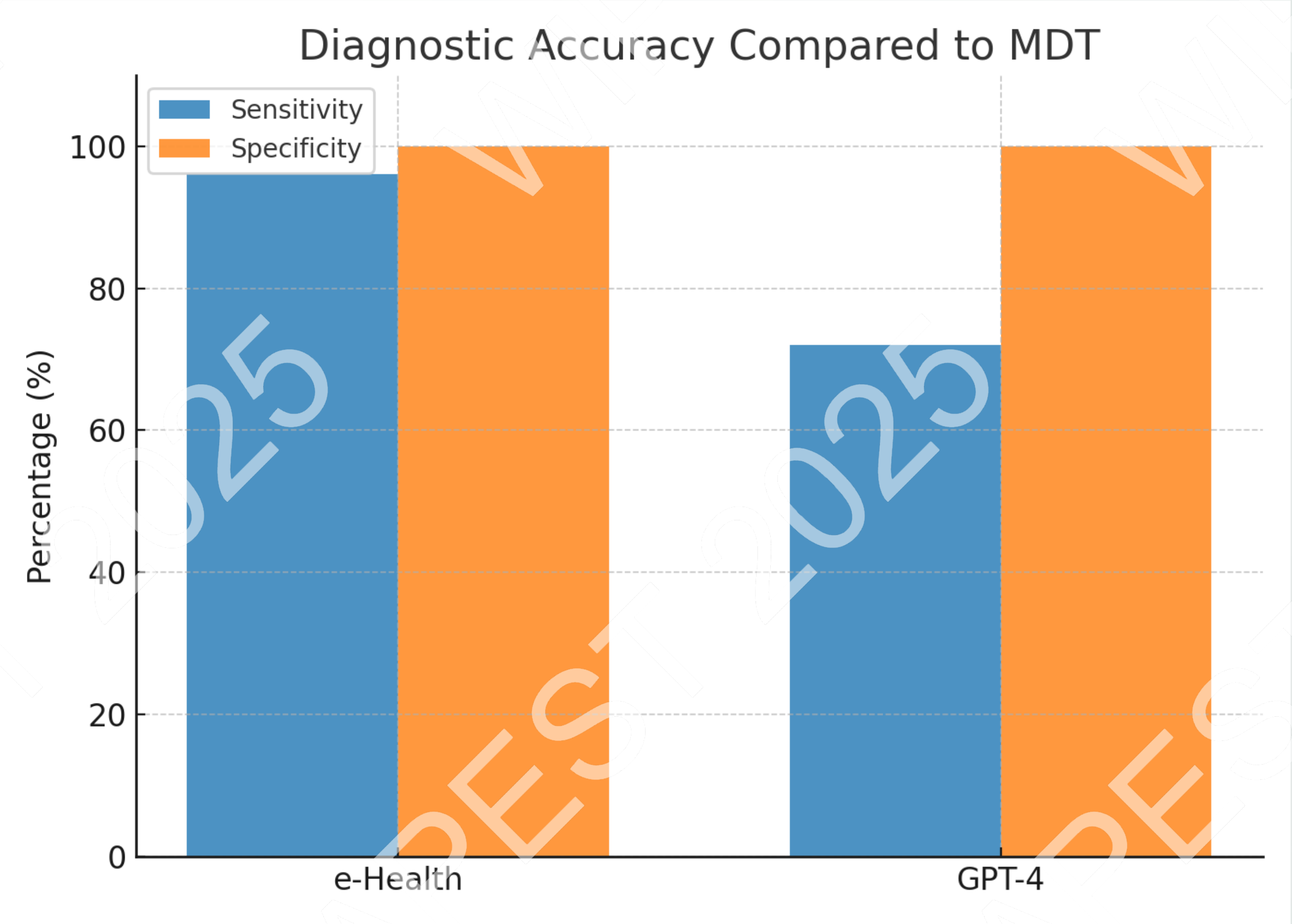
When compared to MDT, both systems had 100% specificity — meaning no false positives, which is clinically crucial.

no inappropriate implants were suggested.

However, sensitivity varied: e-Health detected almost all true positives, while GPT-4 was less sensitive, around 72%

This suggests AI could be safely integrated.

without increasing the risk of wrong implants, but at the same time it may under-select some patients who could have benefited.”



Predictive Value & Potential

- Replicates MDT decisions (partially)
- Useful for referral triage
- Support — not replacement

AI as a filter, not a final decision-maker.

Recent Guidelines on AI in Pain Medicine (ASPN 2025)

Journal of Pain Research, August 2025

ASPN Expert Panel Consensus on AI use in spine & pain interventions

Key recommendations:

- Need for **validation in real-world practice**
- Focus on **patient safety, bias, and data privacy**
- Importance of **clinician training and oversight**

Aligned with SPINE findings: validation in real-world cohorts is essential

Journal of Pain Research
Dovepress
Taylor & Francis Group

Open Access Full Text Article
EXPERT OPINION

Guidelines From the American Society of Pain and Neuroscience for Using Artificial Intelligence in Interventional Spine and Nerve Treatment

Christopher Massey[1], Usman Latif[2], Timothy R Deer[3], Hemant Kalia[4], Maged Guirguis[5], Mark C Bicket[6], Nasir Khatri[7], Reda Tolba[8], Krishnan Chakravarthy[9,10], Ryan Budwany[11], David W Lee[12], Ankur A Patel[13], Alexandra M Moreira[14], Daniel A Jimenez[15,16], Raj G Patel[17], Iden Cowan[17], Sandy Christiansen[18], Derron Wilson[19], Kenneth B Chapman[20,21], Chau Vu[22], Suzanne Manzi[23,24], Sara Nashi[25], Muhammad Waheed[26], Anuj Shah[27], Morad Nasseri[28], Patrick Buchanan[29], Nomen Azeem[30], Erika A Petersen[31], Michael E Schatman[32,33], Alaa Abd-Elsayed[34], Dawood Sayed[2], Sudhir Diwan[35]

[1]Pain Specialists of America, Austin, TX, USA; [2]Department of Anesthesiology and Interventional Pain, The University of Kansas Health System, Kansas City, KS, USA; [3]The Spine and Nerve Center of The Virginias, Charleston, WV, USA; [4]C.R.I.S.P Center for Research & Innovation in Spine & Pain, Rochester, NY, USA; [5]Pain Management Department, Ochsner Health System, New Orleans, LA, USA; [6]Department of Anesthesiology, University of Michigan, Ann Arbor, MI, USA; [7]Insight Health Systems, Flint, MI, USA; [8]Pain Management Department, Cleveland Clinic Abu Dhabi, Abu Dhabi, United Arab Emirates; [9]Division of Pain Medicine, Department of Anesthesiology, University of California San Diego, San Diego, CA, USA; [10]VA San Diego Healthcare, San Diego, CA, USA; [11]PainHealth.ai, NextPain Care, Clearwater, FL, USA; [12]University of California, Irvine/Fullerton Orthopedics, Fullerton, CA, USA; [13]Novant Health Spine Specialists, Winston Salem, NC, USA; [14]Rush University, Department of Anesthesiology, Chicago, IL, USA; [15]Department of Physical Medicine and Rehabilitation, University of Michigan Health-Sparrow, Lansing, MI, USA; [16]Cantor Spine Center, Paley Orthopedic and Spine Institute, Fort Lauderdale, FL, USA; [17]Pain Management, Capitol Pain Institute, Austin, TX, USA; [18]Associate Professor of Anesthesiology and Perioperative Medicine, Oregon Health and Science University, Portland, OR, USA; [19]Goodman Campbell Brain & Spine, Carmel, IN, USA; [20]Department of Anesthesiology, New York University Langone Medical Center, New York, NY, USA; [21]Department of Anesthesiology, the Zucker School of Medicine at Hofstra/Northwell, New York, NY, USA; [22]Evolve Restorative Center, Santa Rosa, CA, USA; [23]Performance Pain and Sports Medicine, Houston, TX, USA; [24]Department of Physical Medicine and Rehabilitation, McGovern Medical School at UT Health, Houston, TX, USA; [25]Interventional Pain & Spine, Trihealth, Cincinnati, OH, USA; [26]Department of Orthopaedic Surgery, Detroit Medical Center/Wayne State University, Detroit, MI, USA; [27]Weill Cornell Tri-Institute, New York, NY, USA; [28]Boomerang Healthcare, Walnut Creek, CA, USA; [29]Spanish Hills Interventional Pain Specialists, Camarillo, CA, USA; [30]Florida Spine & Pain Specialists, Tampa, FL, USA; [31]Department of Neurosurgery, University of Arkansas for Medical Sciences, Little Rock, AR, USA; [32]Department of Anesthesiology, Perioperative Care and Pain Medicine, NYU Grossman School of Medicine, New York, NY, USA; [33]Department of Population Health - Division of Medical Ethics, NYU Grossman School of Medicine, New York, NY, USA; [34]Department of Anesthesiology, University of Wisconsin, Madison, WI, USA; [35]Albert Einstein College of Medicine, Bronx, NY, USA

Correspondence: Christopher Massey, Email chrismasseymd@gmail.com

Introduction: Artificial intelligence (AI) is rapidly evolving and becoming more ubiquitous. Significant advancements have been made in the last few years, driving rapidly increasing adoption. The scale of publications on AI makes it difficult to keep abreast of relevant findings.

Objective: The ASPN Artificial Intelligence Guidelines are designed to help clinicians understand AI and implement it into their practice. This Neuron Project is designed to evolve with the changing landscape of AI.

Methods: An expert panel was chosen to discuss and write the best practice guidelines on AI. The primary authors conducted a literature search on PubMed, cross-referencing key terms in pain management and AI. After a thorough review of the current literature, the information collected was divided into broad categories of potential benefits, potential harms, and ways to ensure the benefits outweigh the potential harms of AI. These guidelines include only the most essential aspects of AI that clinicians need to know and understand before implementing AI into their practice.

Results: Over 12,000 articles were found using the above search results. Many articles were reviews and clinical guidelines. The framework created from these guidelines allowed authors to fill in knowledge gaps and discuss the most critical elements pain clinicians should comprehend about AI.

Received: 8 May 2025
Accepted: 25 July 2025
Published: 20 August 2025

Journal of Pain Research 2025:18 4211–4235 4211

AI = Support Tool, Not Replacement

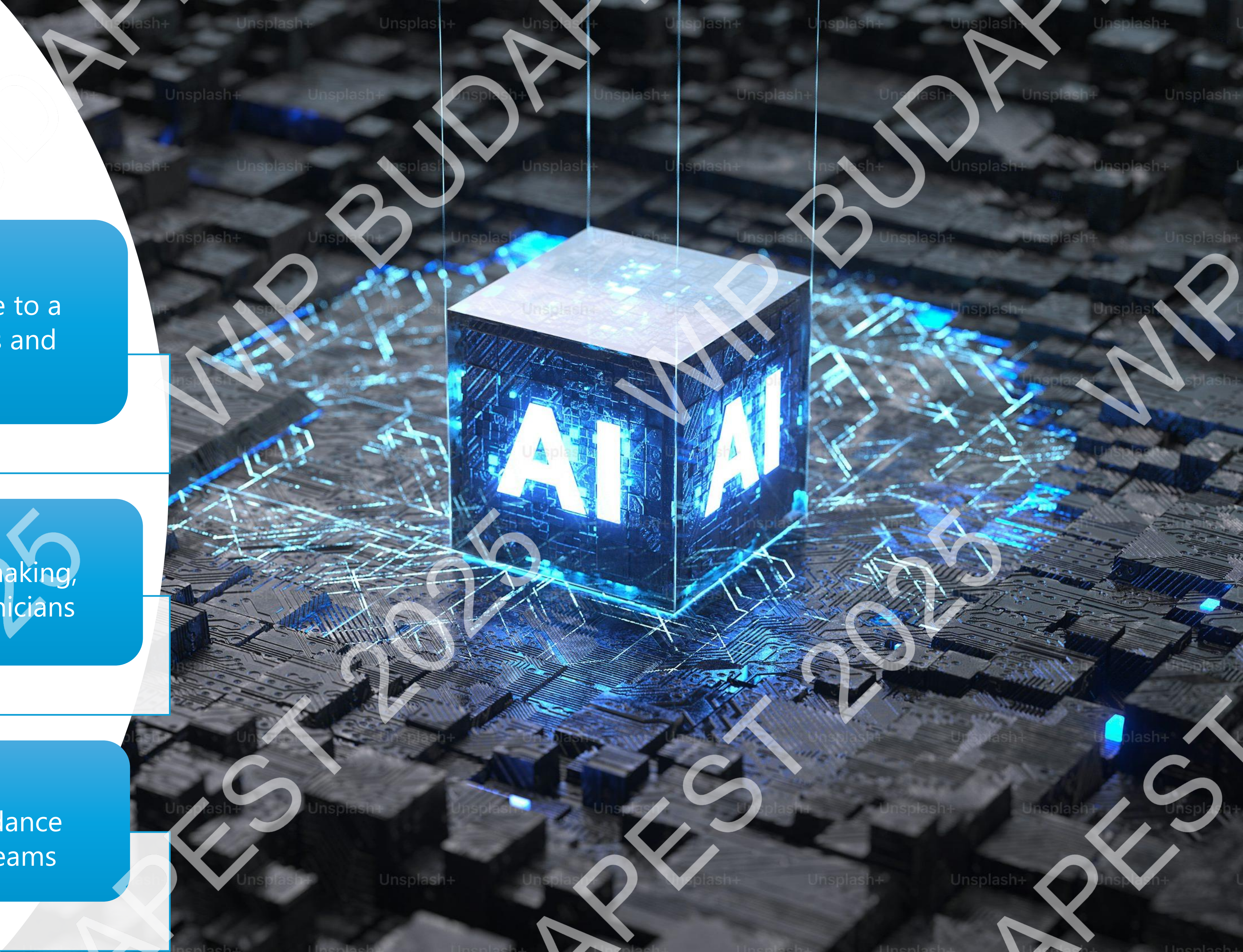
Why AI Integration Helps

🌍 Scalability
AI allows us to expand expertise to a much larger number of patients and centers.

⚖️ Standardization

it ensures consistent decision-making, reducing variability between clinicians and centers

🎓 Support for new centers
AI can act as a training and guidance tool, helping less experienced teams



Limitations & Ethical Considerations

⚖️ Disagreement in borderline cases

AI may under- or over-estimate candidates.

🎯 Risk of bias from training data

Depends on datasets, requires validation.

Human oversight

AI should support, not replace clinical judgment.

Long-Term Vision

AI Pre-Screening → MDT Review → Patient-Centered Decision

Journal of Pain Research
Dovepress
open access to scientific and medical research
Open Access Full Text Article
EDITORIAL

The Future of Pain Medicine: Emerging Technologies, Treatments, and Education

Matthew Slitzky[1], R Jason Yong[2], Giuliano Lo Bianco[3], Trent Emerick[4], Michael E Schatman[5,6], Christopher L Robinson[2]

[1]Burke Rehabilitation, Montefiore Health System, White Plains, NY, USA; [2]Department of Anesthesiology, Perioperative, and Pain Medicine, Harvard Medical School, Brigham and Women's Hospital, Boston, MA, USA; [3]Anesthesiology and Pain Department, Fondazione Istituto G. Giglio Cefalù, Palermo, Italy; [4]Department of Anesthesiology and Perioperative Medicine, Chronic Pain Division, University of Pittsburgh Medical Center, Pittsburgh, PA, USA; [5]Department of Anesthesiology, Perioperative Care, and Pain Medicine, NYU Grossman School of Medicine, New York, NY, USA; [6]Department of Population Health-Division of Medical Ethics, NYU Grossman School of Medicine, New York, NY, USA

Correspondence: Christopher L Robinson, Department of Anesthesiology, Perioperative, and Pain Medicine, Harvard Medical School, Brigham and Women's Hospital, 75 Francis Street Boston, Boston, MA, 02118, USA, Email crobinson48@bwh.harvard.edu

During the early days of chronic pain management, there was a reliance on the use of opioids with a significant increase in opioid prescriptions by physicians in the 1990s and early 2000s.[1] Opioids can and should be utilized to treat pain in the appropriate patient populations and situations, however, due to the initial consequences of the prior boom in opioid use to treat pain there has been resultant decrease in opioid prescription.[1] This decrease in opioid prescriptions and availability have inspired innovators in the field of pain medicine to develop new modalities and procedures that more effectively target a patient's pain generator. The vital task now with the abundance of newer technologies for chronic pain management is to properly educate the next generation of pain physicians on the benefits and risks of these technologies and more clearly define which therapies are evidence-based.

One such innovation being utilized to combat chronic pain is virtual reality (VR) which provides us with a treatment for chronic pain via modalities such as distraction, neural reprocessing, and mindfulness training.[2–4] The distraction element of VR functions by treating pain via reduction of the subjective sensation of pain by redirecting the user's attention away from the pain.[2] Although this modality has already been employed for treating acute and post-surgical pain, it has shown promising results in managing chronic pain conditions.[3,4] As a non-invasive and non-pharmacological approach, it may help tackle the complex challenges of chronic pain, offering a potential pathway to enhance patient outcomes and improve quality of life.[2] Given its high prevalence and significant public health impact, chronic low back pain is currently the most extensively studied chronic pain condition in the field of VR applications.[2] Current data show VR not only has a significant impact on alleviating chronic low back pain, with patients reporting reductions of 2.0 points on the NRS in some studies, but it can also impact secondary outcomes that have major impact on a patient's quality of life.[2,4] Furthermore, some VR technologies have demonstrated a comparable analgesic effect to opioid medications which is extraordinarily impactful as it is being shown to have efficacy without having significant side effects, medication interactions, and being available for patient use at home.[2] These findings highlight the potential of VR as a groundbreaking tool in the management of chronic pain, and innovators are working to integrate it into other modalities to increase the efficacy. Furthermore, via the use of augmented reality (AR), there is the possibility to have a real-time overlay over what the user experiences in the real world. Thus, patients, who otherwise may not be able to go to a physical appointment or live a considerable distance from a healthcare center can have a higher quality form of telehealth.[3] Lastly, there has been sparked interest in using VR to treat nociplastic pain, a type of pain that arises from altered nociception causing the activation of peripheral nociceptors, despite no clear evidence of actual or threatened tissue damage or evidence for disease or lesion of the somatosensory system causing pain. Through the use of VR-based interventions, there is evidence of neuroplastic changes in the sensory and motor regions of the brain resulting in adaptive

Received: 8 August 2024
Accepted: 28 August 2024
Published: 30 August 2024

Emerging Technologies in Pain Medicine (JPR 2024)

- **Virtual Reality (VR):** non-pharmacological analgesia, comparable to opioids.
- **Wearables:** continuous monitoring → correlation with pain, reduced depression and opioid use.
- **Artificial Intelligence (AI):** outcome prediction, personalized neuromodulation.
- **Psychedelics:** novel perspectives for chronic nociplastic pain.
- **Education:** preparing the next generation of pain specialists.

Slitzky M, Yong RJ, Lo Bianco G, Emerick T, Schatman ME, Robinson CL. The Future of Pain Medicine: Emerging Technologies, Treatments, and Education. J Pain Res. 2024 Aug 30;17:2833-2836. doi: 10.2147/JPR.S490581. PMID: 39228514; PMCID: PMC11370752.

Automatic Pain Assessment – From Feasibility to Clinical Consensus

Journal of Pain Research
Dovepress

Open Access Full Text Article

ORIGINAL RESEARCH

Employing the Artificial Intelligence Object Detection Tool YOLOv8 for Real-Time Pain Detection: A Feasibility Study

Marco Cascella[1], Mohammed Naveed Shariff[2], Giuliano Lo Bianco[3], Federica Monaco[4], Francesca Gargano[5], Alessandro Simonini[6], Alfonso Maria Ponsiglione[7], Ornella Piazza[1]

[1]Anesthesia and Pain Medicine, Department of Medicine, Surgery and Dentistry "scuola Medica Salernitana", University of Salerno, Baronissi, 84081, Italy; [2]Department of AI&DS, Rajalakshmi Institute of Technology, Chennai, TN, India; [3]Anesthesiology and Pain Department, Fondazione Istituto G. Giglio Cefalù, Palermo, Italy; [4]Anesthesia and Pain Medicine, ASL NA1, Napoli, Italy; [5]Anesthesia and Intensive Care, U.O.C. Fondazione Policlinico Campus Bio-Medico, Roma, Italy; [6]Pediatric Anesthesia and Intensive Care Unit, Salesi Children's Hospital, Ancona, Italy; [7]Department of Electrical Engineering and Information Technology, University of Naples "federico II", Naples, 0125, Italy

Correspondence: Giuliano Lo Bianco, Anesthesiology and Pain Department, Fondazione Istituto G. Giglio Cefalù, Palermo, Italy, Email giulianolobianco@gmail.com

Introduction: Effective pain management is crucial for patient care, impacting comfort, recovery, and overall well-being. Traditional subjective pain assessment methods can be challenging, particularly in specific patient populations. This research explores an alternative approach using computer vision (CV) to detect pain through facial expressions.
Methods: The study implements the YOLOv8 real-time object detection model to analyze facial expressions indicative of pain. Given four pain datasets, a dataset of pain-expressing faces was compiled, and each image was carefully labeled based on the presence of pain-associated Action Units (AUs). The labeling distinguished between two classes: pain and no pain. The pain category included specific AUs (AU4, AU6, AU7, AU9, AU10, and AU43) following the Prkachin and Solomon Pain Intensity (PSPI) scoring method. Images showing these AUs with a PSPI score above 2 were labeled as expressing pain. The manual labeling process utilized an open-source tool, makesense.ai, to ensure precise annotation. The dataset was then split into training and testing subsets, each containing a mix of pain and no-pain images. The YOLOv8 model underwent iterative training over 10 epochs. The model's performance was validated using precision, recall, and mean Average Precision (mAP) metrics, and F1 score.
Results: When considering all classes collectively, our model attained a mAP of 0.893 at a threshold of 0.5. The precision for "pain" and "nopain" detection was 0.868 and 0.919, respectively. F1 scores for the classes "pain", "nopain", and "all classes" reached a peak value of 0.80. Finally, the model was tested on the Delaware dataset and in a real-world scenario.
Discussion: Despite limitations, this study highlights the promise of using real-time computer vision models for pain detection, with potential applications in clinical settings. Future research will focus on evaluating the model's generalizability across diverse clinical scenarios and its integration into clinical workflows to improve patient care.
Keywords: pain, artificial intelligence, automatic pain assessment, computer vision, action units

Introduction

Pain assessment is a critical component of patient care.[1] Since subjective methods for pain evaluation rely on self-reporting by patients, these approaches can be prone to inaccuracies, especially in cases where patients are unable to communicate effectively, such as infants,[2] individuals with cognitive impairments,[3] or those under sedation.[4]

Automatic pain assessment (APA) refers to a set of research and clinical methods used to provide an objective and quantifiable measure of pain, reducing reliance on subjective self-reports.[5] APA usually implements artificial intelligence (AI) strategies.[6] AI is a multidisciplinary field of computer science focused on designing and developing intelligent systems that mimic human cognitive abilities. Computer vision (CV) is a subfield of AI and computer science that can enable computers to interpret and understand the visual world.[7] It encompasses many tasks, including image and video

Received: 16 August 2024
Accepted: 5 November 2024
Published: 9 November 2024

YOLOv8 feasibility study (JPR 2024): AI/computer vision detects pain via facial expressions (mAP ~0.89).

Expert Consensus (2025): 628 clinicians surveyed + 26 experts → strong agreement on feasibility, multimodal inputs, patient information, clinician training, governance.

Shared message: APA is promising, but must be validated, multimodal, and ethically implemented.

Cascella *et al. J Anesth Analg Crit Care* (2025) 5:29
https://doi.org/10.1186/s44158-025-00249-8

Journal of Anesthesia, Analgesia and Critical Care

SIAARTI

CONSENSUS ARTICLE Open Access

Expert consensus on feasibility and application of automatic pain assessment in routine clinical use

Marco Cascella[1], Alfonso Maria Ponsiglione[2], Vittorio Santoriello[2], Maria Romano[2], Valentina Cerrone[1], Dalila Esposito[1], Mario Montedoro[1], Roberta Pellecchia[2], Gennaro Savoia[14], Giuliano Lo Bianco[3], Massimo Innamorato[4], Silvia Natoli[5,6], Jonathan Montomoli[7], Federico Semeraro[8], Elena Giovanna Bignami[9], Valentina Bellini[9], Matteo Luigi Giuseppe Leoni[10], Felice Occhigrossi[11], Alessandro Vittori[12*], Maria Caterina Pace[13], Pasquale Buonanno[14], Mauro Forte[13], Elisabetta Chinè[15], Roberta Carpenedo[15], Alessandro De Cassai[16,17], Alfonso Papa[18], Maurizio Marchesini[19], Gaetano Terranova[20], Fabrizio Micheli[21], Laura Demartini[22], Franco Marinangeli[23], William Raffaeli[24], Flaminia Coluzzi[25], Andrea Tinnirello[26], Roberto Arcioni[27], Angelo Marra[28], Mohammed Naveed Shariff[29], Federica Monaco[30], Gabriele Finco[31], Alessia Bramanti[32] and Ornella Piazza[1]

Abstract

Background Pain is often difficult to assess, particularly in non-communicative patients. While artificial intelligence (AI)-based objective Automatic Pain Assessment (APA) systems are a promising solution, their clinical implementation raises essential questions, primarily regarding clinician acceptance.

Methods We conducted a survey-to-consensus investigation on the feasibility and application of APA for clinical use. Firstly, the steering committee implemented the CHERRIES guidelines and designed a questionnaire for healthcare professionals. Given the survey results, 26 experts in pain medicine were asked to participate in a two-round consensus by rating 10 statements through a 7-point Likert scale. Consensus was defined as ≥ 75% agreement ("agree" or "completely agree"). For both phases, data was collected through online questionnaires and analyzed quantitatively.

Results For the survey, we collected responses from 628 healthcare professionals. The output highlighted excellent acceptance of the technology and a preference for multidimensional techniques. After two rounds, consensus was achieved on 8 out of 10 statements. Experts agreed on APA utility in supporting healthcare professionals and real-time pain monitoring. A strong consensus (96.2%) supported the need to inform patients about the use and limitations of AI systems. Adequate staff training is mandatory. Moreover, 92.3% agreed on the importance of implementing risk management, data quality control, and AI governance throughout the APA lifecycle. The experts stressed the need for internal and external validation processes and periodic updates, even for research purposes. Consensus was also reached about the importance of involving interdisciplinary stakeholders and addressing regulatory, ethical, and social implications. Multimodal inputs (e.g., physiological signals, facial expressions, speech, and clinical data) in APA systems are recommended. Additionally, APA systems should be capable of grading pain levels (e.g., via NRS),

*Correspondence:
Alessandro Vittori
alexvittori82@gmail.com
Full list of author information is available at the end of the article

Ongoing Work

- SPINE II Validation Study
- Prospective Data Integration
- Neuromodulation Expansion

Conclusions

AI shows promise in supporting outcome forecasting for SCS, but it is not ready to replace human expertise

- fewer false positives

AI is **more conservative**

Good **specificity**

- but sensitivity needs improvement

- **supportive**, not substitutive

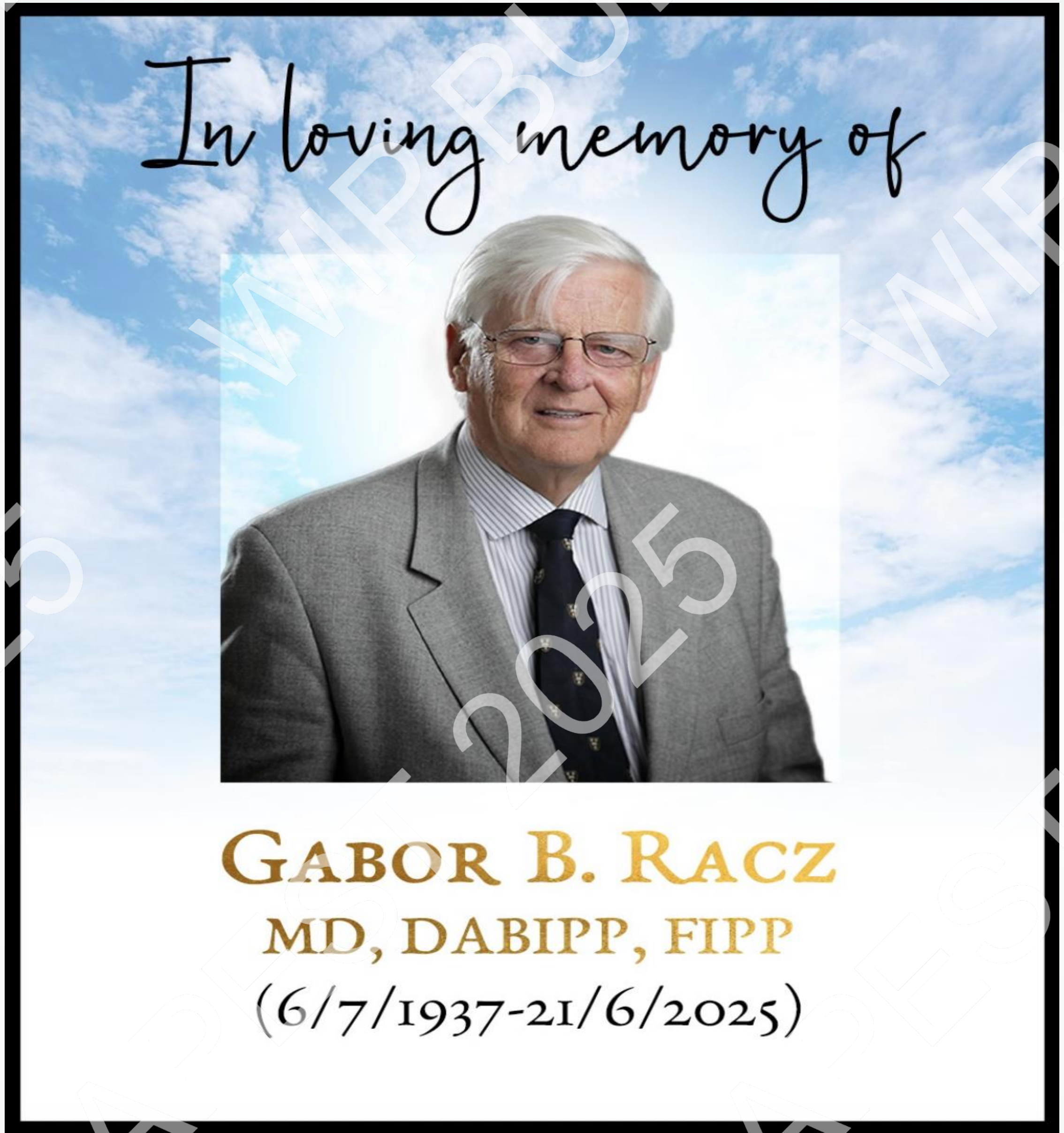
Role

Next step

- large multicentric real-world validation

Q&A: AI in Neuromodulation

- **Implementation Challenges**
- - Integration with current systems
- - Clinician training needs
- ⚖️ **Ethical Considerations**
- - Patient consent & data privacy
- - Responsible AI use
- 👩‍⚕️ **Improved Outcomes**
- - More precision
- - Personalized therapy
- 💬 **Experience Sharing**
- - Encourage participant feedback


In loving memory of
GABOR B. RACZ
MD, DABIPP, FIPP
(6/7/1937-21/6/2025)

ALGOS & WIP Italian Section Congress

27-29 November 2025 Living Place Hotel, Bologna, Italy

WIP 13TH WORLD CONGRESS 2026

21 - 23 September 2026

Hilton Mexico City Reforma

wipcongress.com

Scan the **QR Code** to register your interest

WORLD INSTITUTE OF PAIN®

28th Annual Gabor Racz Advanced Interventional Pain Conference and Workshop

Budapest, Hungary August 25-27, 2025