



29th Annual Gabor Racz
Advanced Interventional
Pain Conference and Workshop
Budapest, Hungary August 24-26, 2026

AI in Pain Medicine: Game Changer or Dangerous Illusion?

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Conflict of Interest

- **Research funding:** Saluda Medical, Medtronic
- **NIH research funding:**
 - **RM1NS128956 :** Mechanisms of Action of Peripheral Nerve Stimulation for the Treatment of Refractory Neuropathic Pain
 - **R01DA058694:** Integrating Tailored Postoperative Opioid Tapering and Pain Management Support for Patients on Long-Term Opioid Use Presenting for Spine Surgery (MIRHIQL)
 - **R34DA060172-01A1:** An Adaptive Psychological Intervention to Improve Pain and Reduce Opioid Use following an Injury
- **Consultant:** Viatrix, Eleni Health



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MY POSITION

AI is already a game changer in pain medicine

1

**It is making the unmeasurable
dimension of pain more measurable**

Pain is the only major clinical outcome with no objective measure. AI applications are developing biomarkers of pain.

2

It is already cleared and in clinical use

Three AI applications carry regulatory clearance across multiple jurisdictions, and one is deployed at scale across health systems today.

3

**It scales expertise to where the burden
is**

The global constraint on pain care is an uneven distribution of expertise leading to geographic disparities in pain care. AI has the potential to bring pain care to areas with unmet need as the current workforce is not scaling fast enough.



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WHERE THE EVIDENCE IS

Six domains three are already in clinical use

1 Measurement

Objective, observer-independent pain assessment

CLEARED · 8 JURISDICTIONS

2 Procedural precision

Real-time anatomy guidance for blocks and injections

CE MARKED · FDA CLEARED

3 Workflow

Ambient documentation, authorization, patient communication

DEPLOYED AT SCALE NOW

4 Predicting benefit

Patient selection for neuromodulation

RCT EVIDENCE, EXPANDING

5 Opioid stewardship

Risk stratification with external validation

VALIDATED ACROSS SYSTEMS

6 Phenotyping

Imaging quantification and data-driven pain subtypes

ARRIVING NEXT



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MODERATOR • QUESTION 1 OF 3 • BOTH SPEAKERS

Q1

What can AI do for pain medicine today that a well-trained clinician cannot?



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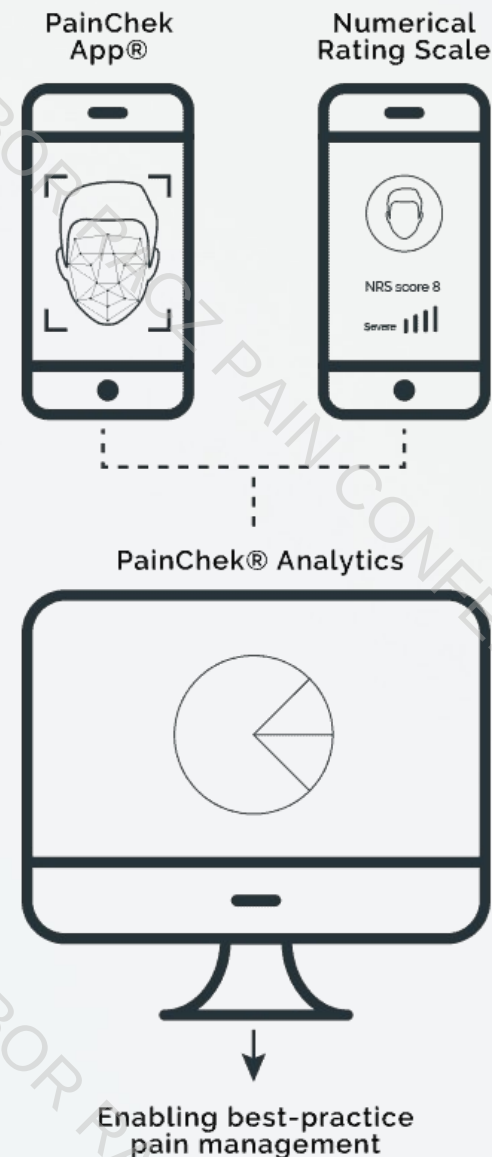
EVIDENCE 1 • MEASUREMENT

Pain measured in patients who cannot speak

PainChek® Adult

CLEARED IN 8 JURISDICTIONS

- Scores pain from facial micro-expressions plus behavioral cues in patients who cannot self-report.
- Cleared in Australia, the EU, the UK, Canada, New Zealand, Singapore and Malaysia; the US FDA De Novo grant created a first-of-its-kind device classification- no predicate device existed.
- Validation against the Abbey Pain Scale: 302 paired assessments in 22 participants, significant correlation with Abbey Pain Scale scores $r=0.818$, internal consistency ($\alpha = 0.810$), moderate single measure intraclass correlation ($ICC = 0.680$) and substantial inter-rater agreement ($\kappa = 0.719$). PMID: 34049501
- 63 patients with clinical dementia diagnosis, 216 PainChek assessments, found to be a valid and reliable pain assessment tool for people with dementia in general hospitals when compared to the Pain Assessment in Advanced Dementia scores. PMID: 39967417

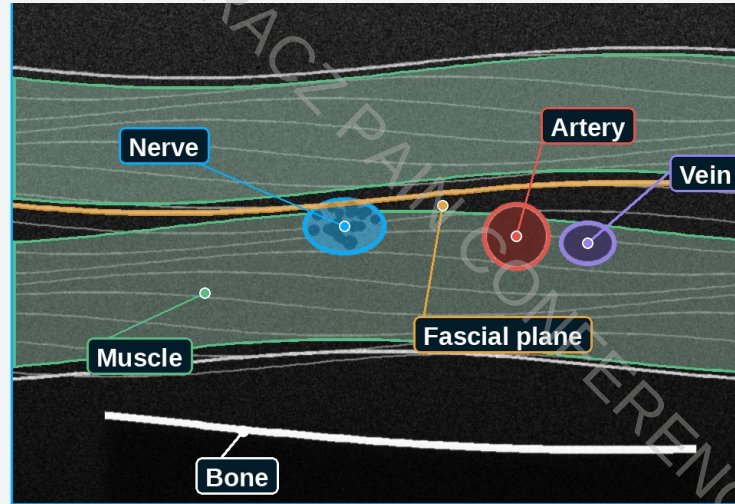
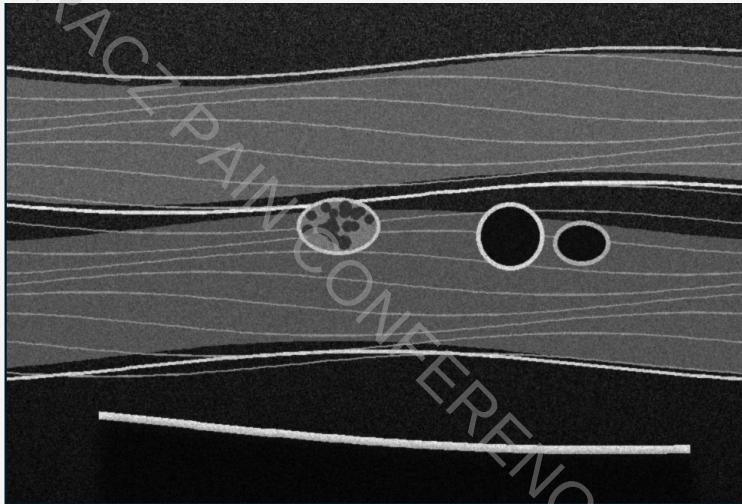




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EVIDENCE 2 • PROCEDURAL PRECISION

Real-time anatomy guidance is cleared and in use



ScanNav Anatomy PNB

CE MARKED • FDA DE NOVO 2022

Color overlay highlighting anatomical structures on live B mode ultrasound. Trained on approximately 800,000 reference ultrasound models; supports common peripheral nerve blocks.

Nerveblox

CE MARKED • FDA 510(k)

Real-time detection of anatomical structures across common regional anesthesia procedures.

In anesthetists who were not experts: correct block view 75.1% (47/62 scans) → 90.3% (56/62 scans) $p=0.031$, correct identification of sono-anatomical structures 77.4% → 88.8% $p=0.002$ (PMID: 36088136)

The gain is concentrated in the least experienced operators. Five billion people lack access to safe, affordable surgical and anesthesia care.



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EVIDENCE 3 • WORKFLOW

Already deployed, already measured, already working

Ambient AI scribes

- Across six health systems (academic and community based), ambulatory care physicians and APPs, 30 days of use reduced ambulatory clinician burnout from 51.9% to 38.8% along with reductions in cognitive task load, and time spent documenting. *Only 60% survey completion rate. (PMID: 41037268)
- A separate randomized trial (DAX vs. Nabia vs. Usual Care) in approximately 238 outpatient physicians found modest reduction in documentation time saved with Nabia (PMID: 41497288)

51.9% → 38.8%

Decreased clinician burnout after 30 days with an ambient scribe

ChatEHR

STANFORD HEALTH CARE

A LLM built in-house and embedded directly in Epic. Clinicians query the record in plain language - allergies, latest lipid panel, prior colonoscopy and its result. Piloted from 2025 and expanding.

Administrative authorization

Language models draft medical-necessity and funding-approval letters with accurate diagnoses and complete step-therapy documentation. Addresses writing the stimulator appeal at nine at night.

Cross-language communication

Imaging reports converted into plain language, and across languages



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MODERATOR • QUESTION 2 OF 3 • BOTH SPEAKERS

Q2

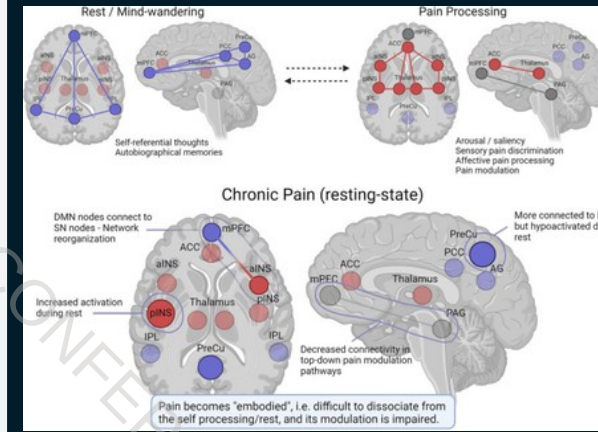
Dr Hah has just shown you three applications with regulatory clearance. Is clearance evidence of clinical benefit, or evidence of a permissive regulatory pathway?

AI Use Cases for SCS and Neuromodulation

- EHR based patient selection
- Neuroimaging biomarkers
- Adaptive Stimulation via wearables
- Real-time parameter optimization
- Continuous remote monitoring

Prediction of treatment response

Machine learning is now being applied to response prediction across epidural injections, radiofrequency ablation and vertebral augmentation.



AI PLATFORM & EHR PARTNER INTEGRATION





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EVIDENCE 5 • OPIOID STEWARDSHIP

Prediction that survived a second health system

What is being predicted

- Incident opioid use disorder
- Persistent post-operative opioid use
- Overdose and opioid-related adverse events
- Relapse risk during treatment for opioid use disorder

Why this generation is different

- Across 44 published ML studies in opioid safety research, 96% came from North America and only 7% reported any external validation (PMID 39820131)
- One model built on 2017-2022 OneFlorida+ EHR to predict 3-month incident OUD risk, then held its performance on 2018-2020 UPMC data: external validation, in a second health system (PMID 41813236)

Current Protocol: Standardized treatment pathways with limited risk stratification. Very conservative opioid prescribing in all care settings.



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EVIDENCE 6 • PHENOTYPING

Radiologic phenotyping in development

Quantitative spine imaging

Deep learning and radiomics generate reproducible measures of disc degeneration, stenosis, endplate change, paraspinal muscle composition and alignment

Unsupervised pain biotypes

Clustering across symptom, psychosocial and physiologic data reproducibly recovers the same subgroups in independent cohorts..

Now moving prospectively

The SPOILS (Software to Predict Outcome In Lumbar Spondylosis) study developed and evaluated a comprehensive framework for predicting Pfirrmann grading and spondylosis severity using both MRI-based deep learning models and radiological geometrical parameters. An AI-driven stratification system can be created to enhance treatment precision and consistency after combining the model with clinical findings.

We have known for thirty years that imaging findings correlate poorly with pain. AI has the potential to generate a reproducible pain phenotype by conglomerating all available patient data.



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MODERATOR • QUESTION 3 OF 3 • BOTH SPEAKERS

Q3

Every model on these slides was trained somewhere specific. If a model built in California cannot be trusted in Budapest or Bangalore, is this a game changer for medicine or for a handful of wealthy health systems?



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THE EQUITY ARGUMENT

Proper AI application can address pain disparities

Grading convention

- The Kellgren-Lawrence grade was derived over 50 years ago in white populations
- Patients with the same radiographic grade report systematically different pain by race and income



A Different Approach

- Pierson et al. trained a convolutional network on 4,172 patients to predict the patient's reported pain directly from the radiograph
- The algorithm accounted for roughly 43% of the unexplained pain disparity in Black patients that the standard grade misses.
- Training set diversity directly contributes to the algorithm's ability to reduce disparities
- Underserved patients (Black patients, lower-education patients, lower-income patients) are less likely to receive knee surgery and more likely to be treated with opioids
- PMID: 33442014