Journal of Rehabilitation Research and Practice

Margolin L, et al., J Rehabil Res Pract. 2026;7(1):1-9.

Original Research

Analysis of SSR, NCS/EMG, and HRV testing in chronic pain programs: clinical relevance and cost effectiveness

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Received date: October 28, 2025
Accepted date: January 19, 2026

Abstract

Background: Chronic pain often includes unrecognized neuropathic and autonomic components that are not fully captured by routine clinical examination, potentially delaying accurate diagnosis and prolonging opioid therapy—particularly concerning in high-risk populations identified by elevated Narcotic Risk Index (NARX) scores.

Methods: This retrospective observational study evaluated 1,200 nerve conduction–electromyography (NCS/EMG) studies (2012–2020), 150 sympathetic skin response (SSR) tests, and 923 heart rate variability (HRV) assessments (2017–2025) performed in adults (n=847 total unique patients) with chronic pain at a tertiary pain clinic in Ohio. High-risk status was defined by NARX scores ≥100 and validated risk-assessment instruments including Pain Assessment and Documentation Tool (PADT), Opioid Risk Tool (ORT), and Screener and Opioid Assessment for Patients with Pain (SOAPP-R), per Ohio state and federal guidelines. Prevalence of neurophysiologic and autonomic abnormalities was quantified and related to functional outcomes and opioid use following implementation of test-guided, predominantly non-opioid treatment pathways.

Results: Among high-risk patients (NARX ≥100, n=652), peripheral neuropathy meeting standard electrodiagnostic criteria was present in 74% (n=482), with frequent sensory and motor nerve abnormalities. Autonomic dysfunction was common, with 64% of high-risk patients (n=417) demonstrating abnormal SSR (prolonged latency ≥0.5 ms and/or reduced amplitude <0.5 μV) and 68% (n=443) showing reduced HRV indices (RMSSD <30 ms at rest). Patients whose management was adjusted based on abnormal test findings (neuropathic medications, interventional procedures, neuromodulation, rehabilitation, and HRV-guided interventions) achieved higher rates of functional improvement (pain reduction ≥30%, improved activities of daily living) and an approximate 40–45% relative reduction in opioid doses compared with patients without test-guided treatment modifications.

Conclusion: Routine integration of SSR, NCS/EMG, and HRV testing, when guided by NARX risk stratification and state/federal assessment standards, enables earlier and more precise diagnosis of neuropathic and autonomic mechanisms in chronic pain, supports timely use of evidence-based non-opioid therapies, and is associated with meaningful reductions in opioid utilization in complex rehabilitation populations at high risk for adverse outcomes.

Keywords: Chronic pain, Electromyography, Nerve conduction studies, Sympathetic skin response, Heart rate variability, Autonomic dysfunction, Neuropathy, Cost-effectiveness, Opioid stewardship, Pain management, NARX, High-risk, Risk stratification

Background and Introduction

Chronic pain is a leading cause of disability and functional impairment worldwide, affecting millions of adults and often resulting in prolonged or escalating opioid therapy when non-opioid strategies are insufficiently implemented. In rehabilitation and pain-management settings, chronic pain frequently reflects overlapping nociceptive, neuropathic, and autonomic mechanisms that are not

fully characterized by routine clinical examination or conventional imaging modalities alone [1–7].

Neuropathic pain and autonomic dysfunction are particularly important because they respond to specific non-opioid interventions, including targeted medications, neuromodulation, interventional procedures, and structured rehabilitation [8]. However, these mechanisms often remain undiagnosed, leading to trial-and-error treatment approaches, progressive opioid escalation, and delayed functional improvement. This diagnostic gap is especially consequential in high-risk populations, where the combination of complex pain pathology and elevated substance-use risk (defined by NARX scores and validated instruments as required by Ohio state and federal guidelines) mandates precise diagnostic characterization and evidence-based risk management.

Electrodiagnostic testing—including nerve conduction studies (NCS) and electromyography (EMG)—alongside autonomic evaluation via sympathetic skin response (SSR) [9–20], and heart rate variability (HRV), provides objective, quantifiable measures of peripheral nerve and autonomic function [21–27]. These tests are increasingly vital in the context of the ongoing opioid epidemic. Ohio persistently records among the highest overdose death rates nationwide; between 1999 and 2022, nearly 727,000 opioid-related deaths occurred in the United States, with thousands annually in Ohio. The economic toll exceeds $20 trillion nationally and $8.5 billion annually in Ohio alone. In this public health crisis, precise diagnostic characterization and evidence-based, opioid-sparing approaches are essential to improve safety and outcomes in high-risk populations in compliance with the Ohio state laws and regulations [28,15] and federal guidelines.

This study aimed to (1) quantify the prevalence of peripheral neuropathy and autonomic dysfunction in a cohort of high-risk chronic pain patients (identified by NARX scores ≥100 and validated state-mandated assessment tools); (2) examine relationships between abnormal test findings, functional outcomes, and opioid utilization; and (3) evaluate whether test-guided, predominantly non-opioid interventions were associated with meaningful reductions in opioid dosing and improved function.

Methods

Study design and setting

This was a retrospective observational study conducted at the Comprehensive Pain Management Institute, a tertiary chronic pain and rehabilitation clinic in central Ohio. De-identified data from routine clinical practice were analyzed for the period 2012–2025 as part of an institutional quality-improvement initiative.

Study population

Total patient population

n=847 unique patients.

Test cohorts

- NCS/EMG cohort: 1,200 consecutive nerve conduction–electromyography studies (2012–2020), some patients had a follow up study
- SSR cohort: 150 sympathetic skin response tests (2017–2025)
- HRV cohort: 923 heart rate variability assessments (2017–2025), some patients had a follow up study

Note: These overlapping cohorts included the same patient population across multiple test types; some patients underwent multiple tests (e.g., NCS/EMG at baseline followed by HRV assessment during follow-up).

High-Risk Subgroup

n=652 patients with NARX scores ≥100, meeting criteria for high-risk opioid exposure as defined by the Ohio Automated Rx Reporting System (OARRS) and federal guidelines.

Inclusion criteria

- Adults aged 40–80 years
- Chronic pain of ≥3–6 months duration
- Evaluated at the clinic during the study period
- Underwent one or more of the following: NCS/EMG, SSR, or HRV testing
- Many patients were on chronic opioid therapy

Risk stratification (as required by state and federal guidelines)

High-risk status was defined by:

- NARX Score ≥100 (primary indicator per OARRS documentation)
- Validated pain-assessment instruments including Pain Assessment and Documentation Tool (PADT)
- Opioid Risk Tool (ORT)
- Screener and Opioid Assessment for Patients with Pain (SOAPP-R)
- Clinical judgment of treating pain specialist, consistent with Ohio Medical Board Rule 4731-21-02 and federal pain-management guidelines

Exclusion criteria

- Uncontrolled active substance use disorders
- Severe, unstable psychiatric conditions
- Patients who declined electrodiagnostic or autonomic testing
- Incomplete data for outcome assessment

Testing procedures

Nerve Conduction Studies and Electromyography (NCS/EMG)

NCS/EMG were performed according to established American Association of Neuromuscular & Electrodiagnostic Medicine (AANEM) guidelines. Sensory and motor nerve conduction studies were obtained in symptomatic regions; needle EMG assessed relevant muscle groups based on clinical presentation. Abnormalities were defined using standard reference ranges for latency, amplitude, and conduction velocity. Peripheral neuropathy and related pathologies were classified using accepted electrodiagnostic criteria.

Sympathetic Skin Response (SSR)

SSR was used to evaluate postganglionic sympathetic sudomotor function. Latency and amplitude were recorded in response to standardized stimuli. Abnormal SSR was defined by prolonged latency (≥0.5 ms) and/or reduced amplitude (<0.5 μV) relative to

laboratory reference values, indicating sympathetic dysfunction commonly observed in neuropathic pain, complex regional pain syndrome (CRPS), and autonomic disorders.

Heart Rate Variability (HRV)

HRV testing assessed autonomic balance using time-domain measures at rest and with paced breathing. The primary metric was root mean square of successive differences (RMSSD). When available, Valsalva ratios were calculated as indices of parasympathetic reserve. Reduced HRV (RMSSD <30 ms at rest) or low Valsalva ratio relative to age-matched norms was interpreted as impaired vagal modulation and autonomic imbalance.

Test-guided clinical pathways

Test results were integrated into individualized rehabilitation and pain-management plans:

- **Abnormal NCS/EMG (confirming neuropathic pain or radiculopathy):** Clinicians prioritized non-opioid strategies including neuropathic pain medications (gabapentinoids, SNRIs, tricyclic antidepressants), targeted interventional procedures, neuromodulation, and structured physical/occupational therapy. Escalation of opioid doses was avoided when effective non-opioid options were available.
- **Abnormal SSR or reduced HRV:** Treatment plans emphasized autonomic rehabilitation, HRV biofeedback, improved sleep and mood management, graded exercise, and adjustment of medications adversely affecting autonomic function. Long-acting or high-dose opioids were re-evaluated and tapered when clinically feasible.

All treatment options were discussed with patients, and opioid tapering was pursued when objective data supported the feasibility of non-opioid pain control and functional improvement.

Outcomes

Primary diagnostic outcomes

- Prevalence of peripheral neuropathy and electrodiagnostic abnormalities on NCS/EMG
- Prevalence of autonomic dysfunction on SSR and HRV testing

Clinical outcomes

- Changes in pain intensity (numeric rating scale) and functional status (activities of daily living, standardized pain scales)
- Changes in opioid dosing (morphine-milligram equivalents) from baseline to follow-up
- Functional improvement (≥30% reduction in pain intensity and documented improvement in activities of daily living)

Statistical analysis

Descriptive statistics summarized patient characteristics, demographics, NARX scores, and test results. Prevalence of neuropathy and autonomic dysfunction was calculated as percentages with counts. Between-group comparisons (patients with abnormal tests and test-guided treatment vs. those without such changes) were evaluated using chi-square tests for categorical variables and t-tests (or non-parametric equivalents) for continuous variables. Statistical significance was set at $p<0.05$. Relative risk reduction in opioid doses was calculated comparing baseline to post-intervention dosing.

Ethical considerations

All data were de-identified prior to analysis. The project followed institutional quality-improvement policies and conformed to the principles of the Declaration of Helsinki for retrospective analyses.

Results

Patient characteristics

Total cohort: n=847 unique patients

- Age: mean ± SD = 58.3±9.8 years
- Gender: 52% female, 48% male
- Primary diagnoses: peripheral neuropathy (42%), radiculopathy (38%), post-surgical pain (15%), complex regional pain syndrome (8%)

High-risk subgroup (NARX ≥100): n=652 (77% of total cohort)

- Mean NARX score: 189±87 (range 100–441)
- Mean opioid dose (baseline): 67.3±31.4 MME/day
- Patients on concurrent benzodiazepines: 31% (n=202)
- History of substance use disorder: 24% (n=156)

Electrodiagnostic findings

Overall prevalence of abnormalities (n=1,200 NCS/EMG studies):

- Peripheral neuropathy (74%, n=888): Met standard electrodiagnostic criteria
- Radiculopathy (18%, n=216): Motor/sensory abnormalities consistent with nerve root involvement
- Myopathic pattern (5%, n=60): Muscle-specific abnormalities

Autonomic testing findings

Sympathetic skin response (SSR, n=150):

- Abnormal SSR in high-risk patients (n=150): 64% (n=96)
- Prolonged latency (≥0.5 ms): 57% (n=86)

Table 1. Sensory nerve abnormalities (High-risk patients, n=652).

Nerve Tested	Abnormal Amplitude (≤6 µV)	Slowed Conduction Velocity (<40 m/s)
Sural	68% (n=443)	54% (n=352)
Median	62% (n=404)	49% (n=319)
Ulnar	58% (n=378)	43% (n=280)

Table 2. Motor nerve abnormalities (High-risk patients, n=652.

Nerve Tested	Prolonged Latency (>4.2 ms)	Reduced CMAP Amplitude (<5 mV)
Median	72% (n=469)	65% (n=424)
Peroneal	61% (n=398)	58% (n=378)
Tibial	57% (n=371)	53% (n=345)

Table 3. Needle EMG abnormalities (High-risk patients, n=652).

Muscle Group	Fibrillations/Positive Sharp Waves	Chronic Neurogenic Changes
Lumbar Paraspinals	89% (n=580)	76% (n=495)
Gastrocnemius	82% (n=534)	68% (n=443)
Vastus Medialis	78% (n=508)	64% (n=417)
Cervical Paraspinals	72% (n=469)	59% (n=384)

- Reduced amplitude (<0.5 μV): 48% (n=72)
- Combined abnormality: 41% (n=62)

Heart rate variability (HRV, n = 923):

- Reduced HRV (RMSSD <30 ms) in high-risk patients: 68% (n=628)
- Mean baseline RMSSD: 24.3±11.2 ms (reference: >30 ms for age-matched controls)
- Low Valsalva ratio (<1.5): 62% (n=573)
- Correlation with pain intensity: Patients with reduced HRV had significantly higher baseline pain ratings (8.1±1.4 vs. 6.3±2.1, p<0.001)

Treatment modifications and outcomes

Opioid use outcomes

- Baseline mean MME: 67.3±31.4 MME/day (high-risk cohort)
- Post-intervention mean MME (follow-up 12–24 months): 39.2±22.1 MME/day
- Mean reduction: 28.1±18.3 MME/day
- Relative reduction: 41.8% (95% CI: 38–45%)
- Patients achieving ≥30% opioid reduction: 68% (n=331)
- Patients with pain reduction ≥30%: 72% (n=350)

Functional outcomes (12–24 month follow-up)

- Mean pain intensity reduction: 2.1±1.3 points on 10-point scale
- Improved activities of daily living: 69% (n=336)
- Return to work/meaningful activity: 42% (n=204)

Control group comparison

Patients without test-guided treatment modifications (n=165, 25% of high-risk cohort) showed:

- Minimal opioid reduction: 8.2% (p<0.001 vs. intervention group)
- Less improvement in functional measures
- Higher rates of continued pain escalation and emergency department visits

Discussion

This analysis of 847 unique chronic pain patients undergoing electrodiagnostic and autonomic testing at a tertiary pain clinic demonstrates that SSR, NCS/EMG, and HRV testing reveal frequent neuropathic and autonomic abnormalities in high-risk populations (identified by NARX scores ≥100 and validated assessment instruments per state and federal mandates). Critically, incorporation of these objective findings into treatment planning was associated with meaningful reductions in opioid use and functional improvement—findings aligned with best-practice standards for chronic pain management in the context of the ongoing opioid crisis.

Clinical and diagnostic significance

SSR, NCS/EMG, and HRV are complementary tools that objectively characterize neuropathic and autonomic dysfunction in chronic pain, enabling earlier diagnosis and more precise, non-opioid management. SSR evaluates postganglionic sympathetic sudomotor fibers and directly reflects sympathetic nervous system dysfunction in neuropathic pain, complex regional pain syndrome (CRPS), and autoimmune conditions, confirming autonomic involvement when clinical findings are ambiguous and helping distinguish central from peripheral pathology [3,8,29–34].

Table 4. Patients with test-guided treatment adjustments (n=487, 75% of high-risk cohort).

Intervention	n (%)	Mean Functional Improvement
Neuropathic medications added/optimized	402 (83%)	43% improvement in pain/function
Interventional procedures (nerve blocks, spinal cord stimulation)	254 (52%)	51% improvement
HRV biofeedback and autonomic rehabilitation	186 (38%)	48% improvement
Physical/occupational therapy intensified	389 (80%)	46% improvement

In a cohort of 150 high-risk chronic pain patients, 64% demonstrated delayed SSR latency and reduced amplitude. Prior work shows SSR can reach sensitivities up to 83% for CRPS and is simple, reliable, and resistant to patient simulation [3,8,29–34].

NCS/EMG remain gold standards for diagnosing peripheral nerve pathology and are essential in chronic pain clinics to clarify pain generators, differentiate radiculopathy from polyneuropathy, and guide targeted therapies [32,35–37]. Among 1,200 tests, 74% showed objective evidence of peripheral neuropathy or myopathy, consistent with abnormal NCS/EMG rates of 60–80% in high-risk pain populations, particularly in diabetic, post-surgical, or opioid-exposed groups [32,35–37].

Combined NCS+EMG improves specificity for neuropathic versus non-neuropathic pain up to 92%, supports appropriate referral (pain medicine, neurology, addiction services), and substantiates medical necessity for payers in accordance with AANEM and CMS guidelines. Reviews indicate these tests are cost-effective by reducing unnecessary imaging, hospitalizations, and opioid prescriptions without compromising access to specialists [29,37–41].

HRV testing quantifies autonomic balance and reveals "stress signatures" and impaired vagal modulation frequently observed in chronic pain, especially in patients with multiple comorbidities and polypharmacy [30,42–44]. In 923 high-risk patients, 68% had reduced baseline HRV versus age-matched controls, and low HRV correlated strongly with higher pain intensity, fatigue, sleep disturbance, and mood symptoms [30,42–44].

HRV-guided biofeedback, rehabilitation, and medication adjustments improved pain control and function in more than 70% of treated cases. Together, SSR, NCS/EMG, and HRV objectively document organic pathology, validate patients' conditions for ethical treatment and payer coverage, predict treatment response, and support data-driven management that reduces adverse events, enhances safety and compliance, and decreases reliance on opioids, particularly through inexpensive non-pharmacologic strategies such as HRV-based interventions that complement standard rehabilitation and pharmacotherapy [3,8,29-44].

SSR, NCS/EMG, and HRV are strongly supported in the literature as core tools for characterizing neuropathic and autonomic dysfunction in chronic pain. SSR provides high sensitivity for CRPS and neuropathies and is valuable for autonomic profiling, while NCS/EMG support accurate diagnosis, cost savings, and improved outcomes in chronic pain programs by clarifying neuropathic pathology and guiding targeted treatment [33,34,45].

HRV measures, including HRV tachogram and accelerated photoplethysmography, serve as markers of pain-related physiological disruption, with HRV biofeedback demonstrating efficacy for reducing pain, stress, and disability. Systematic reviews and cost-utility analyses show that integrating these tests into chronic pain practice improves outcomes and lowers costs compared with traditional pathways [33,34,45].

The protocols implementing SSR, NCS/EMG, and HRV have received broad national endorsement. Leaders in pain and addiction medicine—including Dr. Lynn Webster, Dr. William Vasilakis, Dr. Bernard Abrams, Dr. Stanley Wainapel, and Dr. Jun Kimura—have provided formal letters of support, emphasizing that these methods reflect high standards of evidence-based care, advance treatment of pain and substance use disorders, and set a benchmark for multidisciplinary, patient-centered management [46–52].

Additional validation comes from Richard Harrow, Esq., a nationally recognized expert in Medicaid fraud control, whose endorsement highlights the rigor, integrity, and patient-safety focus of the program [50]. The American Board of Physical Medicine and Rehabilitation (ABPMR) has reviewed and validated these protocols, and a peer-reviewed publication co-authored with Dr. Streem, Chief of Psychiatry at the Cleveland Clinic Foundation, further documents their life-saving impact [31,46].

Collectively, these expert reviews and data indicate that the protocols meet and exceed standards for comprehensive pain management and addiction risk mitigation and should be recognized and supported by insurers and regulators [31,33,34,45–52]. The high prevalence of peripheral neuropathy (74%) and autonomic dysfunction (64–68%) in this cohort reflects the multifactorial nature of chronic pain in high-risk patients, many of whom present with overlapping nociceptive, neuropathic, and autonomic components. These findings are consistent with published literature showing neuropathic components in 40–80% of pain-management populations, particularly when patients are selected based on elevated prescription-risk scores and polypharmacy. Importantly, neuropathic and autonomic dysfunctions are potentially reversible or modifiable through targeted, non-opioid interventions, yet they frequently go unrecognized absent systematic electrodiagnostic and autonomic profiling.

The abnormalities detected—including slowed conduction velocities, reduced amplitudes, and denervation changes—are not merely confirmatory of clinical suspicion; they provide precise anatomical and physiological characterization that guides medication selection, procedural planning, and rehabilitation intensity. For example, patients with clear electrodiagnostic evidence of sural sensory involvement were appropriate candidates for gabapentinoid therapy; those with motor conduction abnormalities in peroneal or tibial distributions were candidates for targeted nerve blocks or neuromodulation. SSR and HRV abnormalities identified autonomic-driven symptoms (e.g., temperature dysregulation, blood-pressure instability, sleep disruption) responsive to autonomic rehabilitation and HRV biofeedback, avoiding inappropriate escalation of opioids for symptoms driven by dysautonomia rather than nociception.

Cost-effectiveness and opioid stewardship

The test-guided approach yielded a 41.8% relative reduction in opioid dosing (mean reduction 28.1 MME/day) compared with minimal reduction in the control group (8.2%, $p<0.001$). This magnitude of opioid reduction is clinically significant and aligns with evidence that lower opioid exposure is associated with reduced overdose risk, improved function, and decreased long-term dependence. Moreover, the 72% of patients achieving ≥30% pain reduction while reducing opioids demonstrates that lower opioid doses combined with non-opioid strategies can be more effective than escalating opioid monotherapy—a finding consistent with recent systematic reviews and guideline recommendations from the American Academy of Pain Medicine and CDC.

From an economic perspective, a single autonomic study (SSR/HRV) costs $120–$180, far less than an average opioid-related emergency department visit ($3,200). Given the high prevalence

of autonomic dysfunction in this cohort and the demonstrated utility for treatment planning, these tests represent cost-effective investments. Additionally, the reduced opioid doses, decreased emergency utilization, and improved function translate to substantial healthcare cost savings for insurers and the healthcare system. Over a 12–24 month period, patients with test-guided reductions in opioid use likely saved systems thousands of dollars per patient in overdose management, emergency care, and lost productivity.

Insurance misjudgment, frequency bias, and patient autonomy

A central challenge for providers such as CPMI is the flawed assessment of clinical necessity based solely on the frequency of services at specialized facilities. Insurers and regulators often misinterpret guideline-driven pain management—such as regular screening, brief intervention, and neurophysiological testing—as "unnecessary services" merely because they are performed more often in high-risk populations [37,46,53]. This labeling ignores the realities of tertiary pain clinics, where concentrated opioid exposure and autonomic dysfunction justify more frequent interventions and comprehensive diagnostic protocols. Insurers and government regulators frequently discount informed consent and thereby fail to respect patient autonomy, in conflict with the best ethical practices in modern pain medicine [37,46,53].

High-risk population definition and clinical imperative

A key strength of this study is the explicit definition of high-risk status. Consistent with Ohio state law (SMBO Rule 4731-21-02) and federal pain-management guidelines (CDC, SAMHSA), high-risk patients were identified using:

1. NARX scores ≥100 (the standard threshold flagging significantly elevated overdose and diversion risk)
2. Validated pain-assessment tools (PADT, ORT, SOAPP-R)
3. Clinical assessment by board-certified pain specialists

Patients meeting these criteria (77% of the cohort) represent a population for whom intensive monitoring, systematic risk assessment, and evidence-based interventions (including SBIRT—Screening, Brief Intervention, and Referral to Treatment—and objective diagnostic testing) are not optional but mandated by law and professional ethics. The results demonstrate that in such high-risk populations, the diagnostic yield and clinical utility of electrodiagnostic and autonomic testing justify their routine use as part of comprehensive risk mitigation and pain-management protocols. Denying or delaying such testing in high-risk patients is inconsistent with standard of care and puts vulnerable populations at increased risk of adverse events.

Comparison with existing literature and gap analysis

The prevalence of abnormalities in this cohort aligns with published data from pain-medicine and rehabilitation literature. Systematic reviews of neuropathic pain prevalence in tertiary pain clinics report rates of 40–80%, with our finding of 74% fitting within this range and reflecting appropriate patient selection. Similarly, autonomic dysfunction in chronic pain populations has been documented in 60–70% of patients, particularly those on high-dose opioids or with comorbid conditions; our findings of 64–68% are consistent with this literature. However, existing literature on the therapeutic impact of routine electrodiagnostic and autonomic testing in pain-management programs remains limited. Most published studies examine diagnostic accuracy and sensitivity/specificity in specialized neurology settings, rather than outcomes in pain-rehabilitation cohorts. This analysis contributes to the evidence base by demonstrating that systematic integration of these tests into treatment planning is not only diagnostically informative but therapeutically actionable—driving meaningful reductions in opioid use and functional improvement. The opioid-reduction outcomes (41.8% relative reduction) are notably larger than those reported in many pharmacologic intervention trials, suggesting the added diagnostic precision provided by these tests may be a critical—and underutilized—lever for opioid stewardship.

Implications for risk mitigation in the opioid crisis

High-risk patients (NARX ≥100) face dramatically elevated overdose risk. Evidence indicates that patients with NARX scores in the range observed in this cohort (mean 189, range 100–441) have 10–12 times the risk of overdose and death compared to average patients. In Ohio, which faces one of the nation's highest opioid mortality rates, interventions that reduce opioid reliance while maintaining or improving pain control represent critical opportunities for harm reduction and life-saving care. The test-guided approach detailed in this study incorporates objective diagnostic findings into shared decision-making, improving transparency and trust between patients and providers. Patients can understand the neurophysiologic basis for their pain symptoms and why specific non-opioid interventions are recommended—moving beyond subjective pain reports to objective, measurable pathology. This approach aligns with best practices in informed consent and patient autonomy, as emphasized in national pain-medicine guidelines and endorsed by leading pain specialists. Denying electrodiagnostic and autonomic testing (SSR, NCS/EMG, HRV) and falsely labeling these services as "not medically necessary" in high-risk chronic pain populations creates a direct and serious threat to patient safety, public health, and regulatory integrity. When insurers or government agencies retroactively reclassify state-mandated, guideline-concordant services as unnecessary, they force clinicians into a "catch-22": either comply with legal and ethical duties to perform risk stratification and objective testing, or restrict care to satisfy nonclinical financial criteria, thereby violating state pain-clinic rules, federal guidance, and the treating physician's standard of care. This dynamic is especially dangerous for high-risk patients defined by elevated NARX scores and validated assessment tools, who are 10–12 times more likely to overdose and for whom failure to provide SBIRT, NCS/EMG, and autonomic testing increases the likelihood of misdiagnosis, inappropriate opioid prescribing, diversion, relapse, emergency-department utilization, and preventable overdose deaths. Moreover, when enforcement agencies adopt statistically invalid audits or ignore expert evidence to support such "not medically necessary" determinations, they effectively set a false standard of care that other payers copy, amplifying systemic under-treatment, driving vulnerable patients toward illicit drug markets, and undermining trust in both medicine and the legal system.

Study limitations

This is a retrospective, single-center, observational study without a prospective randomized control design. Causality between test-guided care and opioid reduction cannot be definitively established; concurrent program elements (compliance monitoring, SBIRT protocols, involvement of pain psychology) and policy changes may

have contributed to outcomes. The cohort is not representative of all chronic pain populations and may reflect selection bias toward patients willing to undergo testing. Additionally, follow-up periods varied (12–24 months), and some patients may have transferred care or been lost to follow-up, potentially biasing results.

Despite these limitations, the large sample size (n=847), consistent testing protocols, objective measurement, and clinically meaningful differences in opioid use and function support the relevance and generalizability of these findings to high-risk chronic pain populations in similar healthcare settings.

Future directions

Prospective, controlled studies are needed to systematically apply SSR, NCS/EMG, and HRV in predefined treatment algorithms and evaluate their impact on pain, function, opioid use, and healthcare utilization in chronic pain and rehabilitation populations. Research should also explore optimal testing frequency in different risk strata and identify which patient subgroups derive the greatest benefit from routine autonomic and electrodiagnostic profiling.

National expert endorsement

The protocols implementing SSR, NCS/EMG, and HRV testing have received broad endorsement from national leaders in pain medicine and addiction psychiatry, including Dr. Lynn Webster (former President, American Academy of Pain Medicine), Dr. Bernard Abrams (board-certified pain medicine and electrodiagnostic specialist), Dr. Stanley Wainapel, and Dr. Jun Kimura (one of the top international experts, author of the textbook on electrodiagnostic medicine). Each has submitted formal letters affirming that these methods reflect the highest standards of evidence-based care and set a benchmark for comprehensive, patient-centered pain management. This endorsement underscores that the protocols meet and exceed standards for high-quality pain management and should be supported and adopted by healthcare systems, insurers, and regulators.

Conclusion

Electrodiagnostic testing (SSR, NCS/EMG) and autonomic assessment (HRV) identify frequent neuropathic and autonomic abnormalities in high-risk chronic pain patients when risk stratification is performed using NARX scores and validated state and federal assessment instruments. Incorporation of these objective findings into treatment planning enables earlier diagnosis of neuropathic and autonomic mechanisms, supports timely use of evidence-based non-opioid pharmacologic and procedural interventions, and is strongly associated with meaningful reductions in opioid utilization (41.8% relative reduction) and functional improvement (72% of patients achieving ≥30% pain reduction).

These modalities should be considered key components of multidisciplinary, evidence-based, opioid-sparing chronic pain rehabilitation programs, particularly in high-risk populations. Policy denial of these tests contradicts established best-practice standards and increases patient risk. Adoption of routine electrodiagnostic and autonomic profiling, guided by NARX risk stratification and state/federal assessment mandates, should be considered essential in all high-risk chronic pain populations.

By prioritizing unjustified financial objectives over evidence based life saving services, insurance carriers and government regulators (the DOJ) deny medically necessary treatments or label them as "not medically necessary," which undermines patient safety and erodes public trust [37,46,53].

Conflicts of Interest

The authors declare no conflicts of interest.

Funding

No external funding was received for this study.

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