Improving Injectate Reproducibility in an Academic Interventional Pain Program: A Quality Improvement Initiative

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BACKGROUND

- **Significant variability** in injectate composition is well-documented among pain physicians.[1,2]
- **Multisociety consensus guidelines** exist but rely on overall **limited evidence**, cannot address all clinical scenarios, and real-world **adherence remains inconsistent**.[3,4,5,6]
- Academic training centers may **amplify** variability through trainee exposure to different practices from multiple supervising attendings.
- Inconsistent injectate practices + poor **reproducibility** can impair trainee **education**, standardization of care, and **patient safety**.
- Interventional pain procedures, particularly spinal epidural steroid injections (ESIs), carry serious risks including worsening **pain**, **disability**, or **death** if performed incorrectly.

QI OBJECTIVES

1. ***Improve the reproducibility of attending-specific injectate protocols through an iterative clarification process.***
2. ***Characterize injectate variability and provider consistency over time, with a particular focus on neuraxial procedures, to identify opportunities for standardization.***

METHODS

- Setting: **Academic** interventional **pain fellowship** program within a **tertiary cancer center**
- **10 Interventional Pain Attendings, 6 Pain Fellows**
- Baseline injectate preferences **(V0)** and current clinical practices **(VF)** were collected via an **iterative clarification process** from all attending physicians for **23** interventional pain **procedures**.
- **Reproducibility**, interprovider **variability**, and intraprovider **consistency over time** were assessed, and clinical practices were analyzed.

Table 1. *Definitions of Study Terms*

Term	Criteria
Consistency	Provider's historical (V0) practice is consistent with current (VF) practice based on: 1. Current practice uses the same medications as historical practice (V0). 2. Current practice uses the same medication amounts and concentrations as historical practice (V0).
Reproducibility	Provider's current practice contains sufficient detail for consistent preparation, including: 1. All required medications to perform the injection. 2. All medication volumes and concentrations, where applicable. 3. Medication amounts by level and/or side, where applicable.

*Consistency assessed using VFfinal practice for all providers.

Table 2. *Procedure Categories*

Category	N	Procedures Included
Neuraxial epidural steroid injections (ESI)*	5	Cervical, thoracic, transforaminal lumbar, interlaminar lumbar, and caudal ESI
Musculoskeletal injections	7	Shoulder, intra-articular hip, knee, and sacroiliac joint injections; greater trochanteric bursa injection; suprascapular nerve block; trigger point injections
Deep blocks	6	Non-spinal and non-musculoskeletal injections requiring advanced imaging guidance: splanchnic plexus, superior hypogastric plexus, and ganglion impar neurolysis; lumbar sympathetic block; stellate ganglion block; intercostal nerve block
Medial branch and intra-articular facet injections	5	Cervical, thoracic, and lumbar medial branch blocks; lumbar medial branch radiofrequency ablation; lumbar intra-articular facet injection

*The four primary neuraxial procedures were cervical, thoracic, lumbar interlaminar, and transforaminal ESIs.

FIGURES

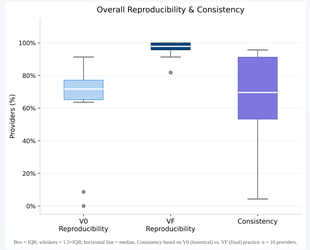


Figure 1: *Provider-level injectate reproducibility at baseline (V0) and following iterative clarification (VF), and intraprovider consistency between V0 and VF across all 23 procedures (n = 10 providers)*

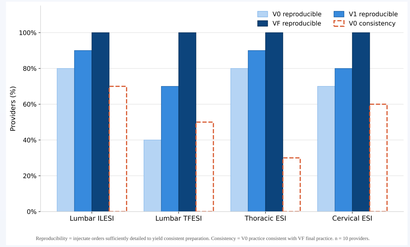


Figure 2: *Reproducibility at V0, V1, and VF and consistency over time (V0 vs VF) for primary neuraxial ESI procedures (n = 10 providers)*

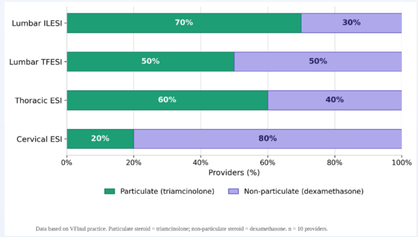


Figure 3: *Proportion of providers utilizing particulate (triamcinolone) versus non-particulate (dexamethasone) steroids for primary neuraxial ESI procedures.*

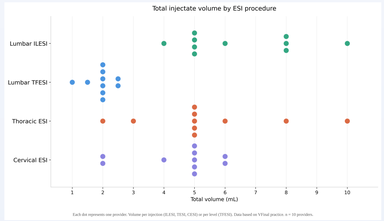


Figure 4: *Distribution of total injectate volumes selected by providers for primary neuraxial ESI procedures based on finalized (VF) practice.* Volume reported per injection (ILESI, TESI, CESI) or per level (TFESI). Each dot represents one provider.

Table 3. Reproducibility and Consistency Over Time

Procedure category	n	REPRODUCIBILITY Baseline (V0)	Final (VF)	V0 → VF	Δ pp	CONSISTENCY Over time
All procedures	23	63.8 ± 30.9	96.0 ± 5.8		+32.2	70.5 ± 28.3
BY PROCEDURE CATEGORY						
Neuraxial	5	70.0 ± 39.2	96.0 ± 8.4		+26.0	54.0 ± 36.6
Primary neuraxial ESIs †	*4*	*67.5*	*100*		*+32.5*	*52.5 ± 17.1*
Musculoskeletal injections	7	76.9 ± 41.0	100.0 ± 0.0		+23.1	82.9 ± 32.2
Deep blocks	6	65.8 ± 28.5	100.0 ± 0.0		+34.2	74.7 ± 25.8
Medial branch blocks & Facet injections	5	38.0 ± 33.3	86.0 ± 26.7		+48.0	66.0 ± 37.8

Values are mean ± SD (%). V0, baseline formulation; VF, final formulation; Δ pp, absolute change in percentage points; ESI, epidural steroid injection. ● V0 ● VF (0–100% scale)
† Cervical, thoracic, interlaminar lumbar, and transforaminal lumbar ESIs; a subset of the neuraxial category.

RESULTS

- Overall **reproducibility** rose from **64% to 96%** after the iterative process
  - Primary **neuraxial** procedures increased from 67.5% to **100%**
- Reproducibility **improved in all four procedure categories**, reaching 100% for MSK injections, deep blocks, and the four primary neuraxial ESIs
- Overall **consistency** over time was **70.5%**
  - Consistency was **highest for MSK injections** (82.9%) and **lowest for neuraxial procedures** (54.0%)
- Clinical Practices:
  - Steroid preference **varied most** for lumbar **transforaminal ESIs** (50:50 split between particulate vs. non-particulate steroids), while **cervical ESIs** had the **strongest consensus** (80% dexamethasone preference)
- **No consensus** could be reached between any providers for **ganglion impar blocks**

DISCUSSION

- **Significant variability** was demonstrated within a single academic center.
- Initial descriptions frequently lacked sufficient detail, but the iterative data collection process successfully **improved reproducibility.**
- Low consistency over time may be a positive indicator of **ongoing learning and adaptation.**
- **Consensus** was often greatest where **risks are highest** or **guidelines** are the strongest (e.g., cervical ESIs).

CONCLUSIONS

- **Although complete standardization of injectate formulations was not achieved, the iterative process transformed individualized preferences into highly reproducible protocols.**
- **For academic pain programs, reproducible protocol documentation, rather than uniformity, offers a more attainable approach for improving fellow education and procedural preparation while preserving physician autonomy.**

REFERENCES

1. Blankstein M, Lentine B, Nelms NJ. Common practices in intra-articular corticosteroid injection for the treatment of knee osteoarthritis: a survey of the American association of hip and knee surgeons membership. The Journal of Arthroplasty. 2021;36(3):845-850. doi:10.1016/j.arth.2020.09.022
2. Vydra D, McCormick Z, Clements N, Nagpal A, Julia J, Cushman D. Current trends in steroid dose choice and frequency of administration of epidural steroid injections: a survey study. PM&R. 2020;12(1):49-54. doi:10.1002/pmrj.12192
3. Benzon HT, Doshi TL, Maus T, et al. Multisociety multispecialty consensus recommendations on corticosteroid injections for facet joint and sacroiliac joint pain. Reg Anesth Pain Med. Published online January 22, 2026:rapm-2025-107347. doi:10.1136/rapm-2025-107347
4. Sayed D, Grider J, Strand N, et al. The american society of pain and neuroscience (Aspn) evidence-based clinical guideline of interventional treatments for low back pain. JPR. 2022;15:3729-3832. doi:10.2147/JPR.S386879
5. Cohen SP, Bhaskar A, Bhatia A, et al. Consensus practice guidelines on interventions for lumbar facet joint pain from a multispecialty, international working group. Reg Anesth Pain Med. 2020;45(6):424-467. doi:10.1136/rapm-2019-101243
6. Benzon HT, Elmofty D, Shankar H, et al. Use of corticosteroids for adult chronic pain interventions: sympathetic and peripheral nerve blocks, trigger point injections - guidelines from the american society of regional anesthesia and pain medicine, the american academy of pain medicine, the american society of interventional pain physicians, and the international pain and spine intervention society. Reg Anesth Pain Med. Published online July 16, 2024:rapm-2024-105593. doi:10.1136/rapm-2024-105593