



CORRESPONDENCE

Open Access



# Bridging complexity: AI-guided regional anaesthesia in anticoagulated trauma patients

Giuseppe Pascarella<sup>1\*</sup>, Michele Carella<sup>2,3</sup>, Alessandro Strumia<sup>1</sup>, Massimiliano Carassiti<sup>1</sup> and Fabio Costa<sup>1</sup>

**Keywords** Anaesthesia, Antithrombotic, Artificial intelligence, Fracture, Trauma

Dear Editor,

Regional anaesthesia has established benefits for perioperative analgesia and overall recovery, particularly in trauma patients requiring urgent fixation of major fractures, by reducing systemic opioid requirements, facilitating early mobilization, and potentially lowering rates of postoperative complications [1]. However, in everyday practice, a substantial subset of these patients is receiving antithrombotic therapy at the time of surgery, and the balance between analgesic gain and bleeding risk remains poorly defined. Although recent European and American guidelines provide unprecedented granularity by distinguishing neuraxial techniques and ‘deep’ peripheral blocks from more compressible ‘superficial’ techniques and by stratifying recommendations according to low-versus high-dose regimens of direct oral anticoagulants (DOACs), their complexity may hinder rapid decision-making in the high-pressure trauma setting [2, 3]. In daily practice, regional anaesthesia decisions must often be tailored to multiple variables: fracture site, anticoagulant type and dose, renal function, timing of last administration, and the practical compressibility of the block

site. The gap between detailed consensus statements and actionable, evidence-driven protocols may thus become a critical barrier to broader uptake of regional techniques in this vulnerable population.

To explore whether artificial intelligence (AI) could help bridge this gap by rapidly interpreting complex recommendations and tailoring block choices, we conducted a proof-of-concept exercise with 10 anonymized trauma scenarios (4 hip fractures, 2 distal femur fractures, 2 bimalleolar ankle fractures, 1 proximal humerus fracture, 1 multiple-rib fracture with hemothorax).

For each case, we provided the following: fracture type and surgical indication, antithrombotic drug and dose, timing of last administration, and renal clearance calculated using the Cockcroft–Gault formula.

Then, the ESAIC/ESRA and ASRA guidelines were uploaded in full-text PDF format via the file upload function of the AI software ChatGPT-4 (Open AI), accessed via chat.openai.com in July 2025. All information about the analysed scenarios was manually inputted directly into the context window. Subsequently, we posed two standardized questions for every scenario with the following exact format:

- 1 “Is neuraxial block indicated?”
- 2 “Which peripheral nerve blocks are indicated?”

Three authors (G. P., Mi. C., F. C.) expert in regional anaesthesia independently reviewed all AI responses for clinical appropriateness and adherence to the guidelines. In no case were there disagreements.

The AI indications for specific scenarios are shown in Table 1:

\*Correspondence:

Giuseppe Pascarella  
g.pascarella@policlinicocampus.it

<sup>1</sup> Unit of Anesthesia and Intensive Care, Fondazione Policlinico Universitario Campus Bio-Medico, Rome, Italy

<sup>2</sup> Department of Anesthesia and Intensive Care Medicine, Liege University Hospital, Liège, Belgium

<sup>3</sup> Inflammation and Enhanced Rehabilitation Laboratory (Regional Anesthesia and Analgesia), GIGA-I3 Thematic Unit, Université de Liège GIGA Institute, Liège, Belgium



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by-nc-nd/4.0/>.

**Table 1** AI-generated regional anaesthesia indications for patients on antithrombotic drugs scheduled for trauma surgery

Patient	Condition	Antithrombotic drug	Dosage	Time since last intake	CrCl	Are neuraxial blocks indicated?	What peripheral blocks are indicated?
1	Hip fracture	Rivaroxaban	20 mg (HD)	24 h	53	No ✓	Fascia iliaca ✓* Femoral nerve ✓* LFC nerve ✓
2	Hip fracture	Dabigatran	150 mg BID (HD)	48 h	63	No ✓	Same as above ✓
3	Hip fracture	Rivaroxaban	10 mg (LD)	24 h	18	No ✓	Same as above ✓
4	Hip fracture	Apixaban	2.5 mg BID (LD)	40 h	75	Yes ✓	Same as above ✓ PENG ✓
5	Distal femur fracture	Edoxaban	60 mg (HD)	24 h	64	No ✓	Fascia iliaca ✓ Femoral nerve ✓ LFC nerve ✓
6	Distal femur fracture	Clopidogrel	75 mg	48 h	27	No ✓	Same as above ✓
7	Bimalleolar fracture	Apixaban	5 mg BID (HD)	48 h	104	No ✓	Popliteal sciatic nerve ✓ Saphenous nerve ✓
8	Bimalleolar fracture	Rivaroxaban	20 mg (HD)	72 h	90	Yes ✓	Same as above ✓
9	Humerus fracture	Dabigatran	110 mg BID (HD)	48 h	24	No ✓	Interscalene BP ✓ Supraclavicular BP ✓
10	Rib fracture + haemothorax	Clopidogrel	75 mg	12 h	126	No ✓	ESP ✓ SAP ✓ Intercostal ✓

AI was asked to provide a correct indication for the use of neuraxial and/or peripheral block

CrCl Creatinine clearance, BID Twice a day, HD High dosage, LD Low dosage, LFC Lateral femoral cutaneous, BP Brachial plexus, ESP Erector spinae plane, SAP Serratus anterior plane, ✓ Correct answer

\*recommended by PROSPECT guidelines

- Neuraxial block feasibility: In 8/10 cases, the model correctly contraindicated neuraxial techniques due to insufficient anticoagulant-free intervals or reduced clearance; in 2/10, it correctly affirmed feasibility where guideline criteria were met.
- Peripheral block selection: The model consistently distinguished superficial from deep approaches, recommending only compressible, low-risk blocks appropriate to antithrombotic discontinuation time and fracture site (e.g. femoral nerve or fascia iliaca for hip and distal femur, popliteal block for bimalleolar fractures, supraclavicular approaches to brachial plexus for humerus, fascial plane blocks for ribs analgesia)

It is important to note that the AI was not explicitly informed of whether a regimen was high or low dose; rather, it inferred this from the drug, dosage, and frequency, based on the uploaded guidelines. Moreover, despite the absence of explicit prioritization, the AI's suggestions included several blocks that align with PROSPECT recommendations, such as femoral nerve and fascia iliaca blocks for femur fractures. However, it is our opinion that the final selection among the allowed techniques should remain under the discretion

of the clinician's judgement, which must consider not only international recommendations but also personal expertise, anatomical variation, and patient-specific considerations.

These findings illustrate that AI can swiftly apply granular consensus criteria to patient-specific variables, offering clear, contextualized guidance. By accelerating complex risk–benefit assessments, such tools may enhance the consistency of regional anaesthesia decisions, particularly valuable for less experienced providers in busy trauma suites. These results resonate with a growing body of evidence highlighting the role of AI in enhancing regional anaesthesia practice. In particular, different AI-powered ultrasound solutions have been shown to improve anatomical landmark identification, needle visualization, and training processes, although evidence remains limited, and ethical concerns about data governance may arise [4]. However, these developments strongly suggest that AI-assisted ultrasound might help reduce human errors, ease the learning process, and improve block success rates [5]. This could be especially important for trauma patients on anticoagulants, where technical precision can make a real difference in safety. As evidence continues to evolve, AI tools could become a helpful ally for clinicians, especially when they need to make real-time challenging decisions based on multiple

variables. However, prospective validation is essential. Randomized or pragmatic trials should compare bleeding complications, block success, analgesic quality, and functional recovery in anticoagulated patients managed with AI-assisted protocols versus standard practice. Additionally, AI-integrated ultrasound guidance warrants rigorous evaluation for its potential to improve needle visualization, reduce technical errors, and further mitigate haemorrhagic risk. Ethical governance and data-privacy frameworks must evolve in parallel to safeguard patient information.

This experience has some limitations: it relied on raw outputs from the publicly available ChatGPT-4 model, without fine-tuning. This approach, while widely accessible, is subject to known limitations such as non-determinism and response variability; although the presented scenarios aimed to reflect realistic trauma presentation, generalizability is limited, especially in more complex contexts. Moreover, AI software includes some limits such as hallucination (plausible but incorrect outputs), non-determinism (different responses to the same prompt), and sensitivity to prompt wording. These factors highlight the need for cautious interpretation and human oversight.

Based on this preliminary experience, it is our opinion that well-structured AI tools, used alongside multidisciplinary protocols, could bridge the divide between complex expert consensus and bedside practice. By offering rapid, contextualized guidance on anticoagulant timing, block compressibility, and technique selection, AI has the potential to expand safe access to regional anaesthesia for trauma patients on antithrombotic therapy. We hope that future clinical investigations will define its impact on patient safety, analgesic quality, and resource utilization in this challenging arena.

#### Authors' contributions

GP (Conceptualization; Investigation; Writing – original draft). MiC (Writing – review & editing). AS (Writing – review & editing). MaC (Supervision). FC (Investigation; Writing – review & editing).

#### Funding

None.

#### Data availability

No datasets were generated or analysed during the current study.

#### Declarations

#### Competing interests

The authors declare no competing interests.

Received: 26 August 2025 Accepted: 7 October 2025

Published online: 19 November 2025

#### References

1. Van Waesberghe J, Stevanovic A, Rossaint R, Coburn M (2017) General vs. neuraxial anaesthesia in hip fracture patients: a systematic review and meta-analysis. *BMC Anesthesiol* 17:87
2. Kietaihl S, Ferrandis R, Godier A et al (2022) Regional anaesthesia in patients on antithrombotic drugs: joint ESAIC/ESRA guidelines. *Eur J Anaesthesiol* 39:100–132
3. Kopp SL, Vandermeulen E, McBane RD, Perlas A, Leffert L, Horlocker T (2025) Regional anesthesia in the patient receiving antithrombotic or thrombolytic therapy: American Society of Regional Anesthesia and Pain Medicine Evidence-Based Guidelines (fifth edition). *Reg Anesth Pain Med rapm-2024–105766*. <https://doi.org/10.1136/rapm-2024-105766>. Epub ahead of print
4. Harris J, Kamming D, Bowness JS (2025) Artificial intelligence in regional anesthesia. *Curr Opin Anaesthesiol* 38(5):605–610. <https://doi.org/10.1097/ACO.0000000000001505>. Epub 2025 Apr 21
5. Swain BP, Nag DS, Anand R, Kumar H, Ganguly PK, Singh N (2024) Current evidence on artificial intelligence in regional anesthesia. *World J Clin Cases* 12:6613–6619

#### Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.