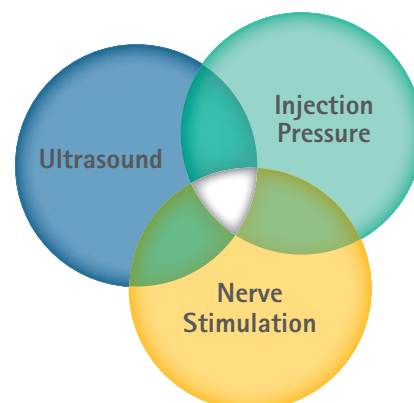


# Triple Monitoring

Enhancing Safety in Peripheral Nerve Blocks



Regional Anesthesia



# Triple Monitoring

## A Multimodal Approach for Peripheral Nerve Blocks

**Ultrasound**

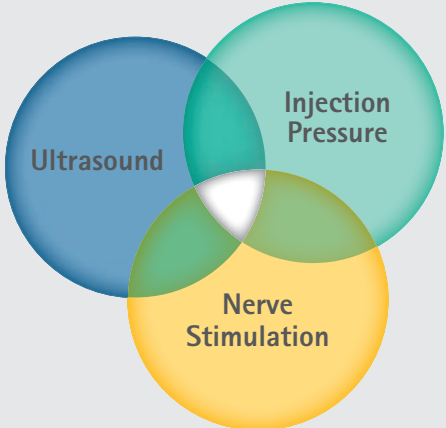
Monitors needle advancement and spread of local anesthetic in real time.<sup>12,13</sup>

**Nerve Stimulation**

Identifies nerves by eliciting specific distal motor response; response at < 0.5 mA may indicate needle-nerve-contact or intraneural placement of the needle.<sup>1,5,7</sup>

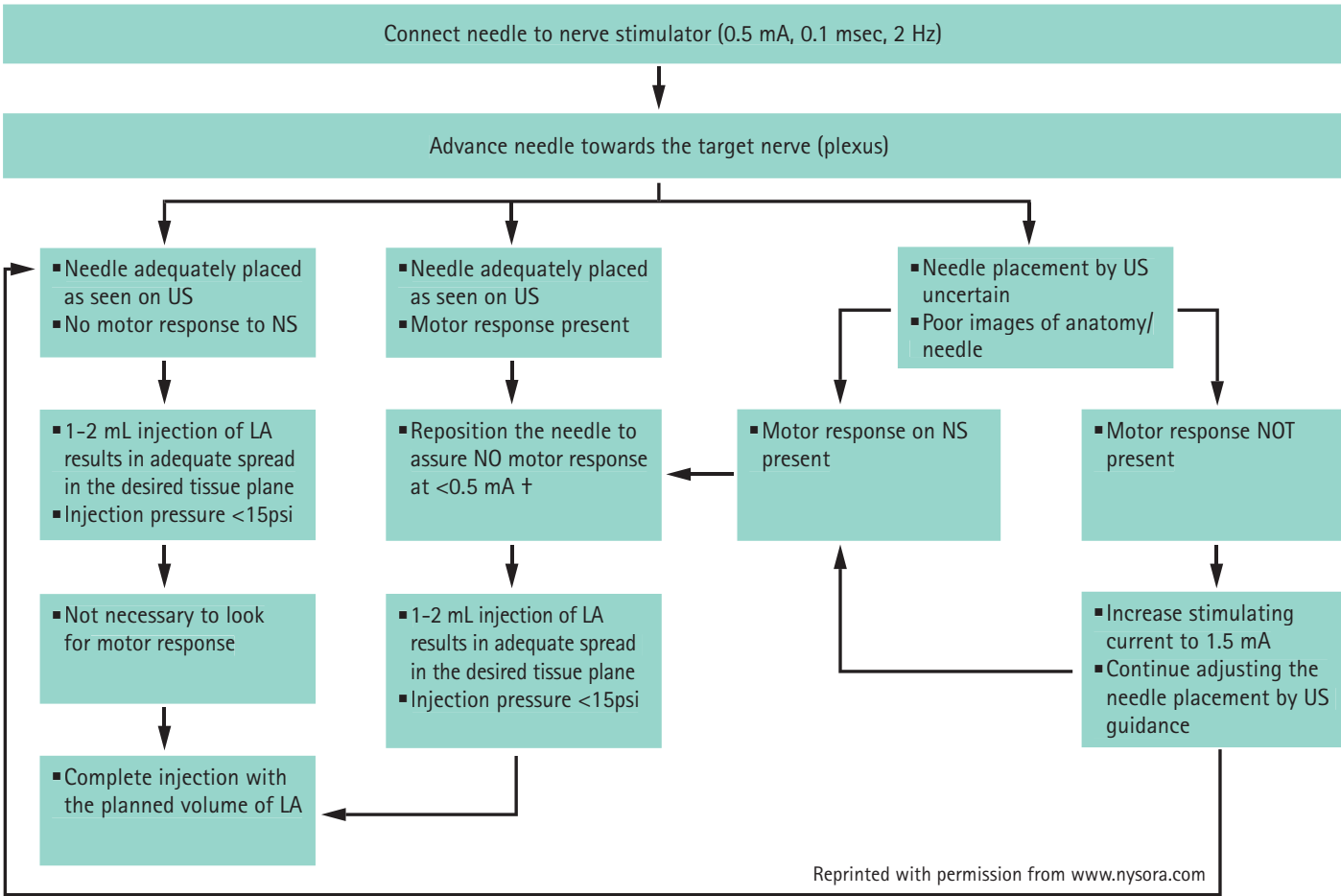
**Injection Pressure**

High opening injection pressure (> 15psi) may indicate or detect needle-nerve contact, intrafascicular needle placement, injection into poorly compliant tissues (fasciae, tendons) or needle obstruction.<sup>1,4</sup>



### Suggested Standard Monitoring for Nerve Blocks<sup>9</sup>

#### Combined Monitoring: Ultrasound + Nerve Stimulation + Opening Injection Pressure



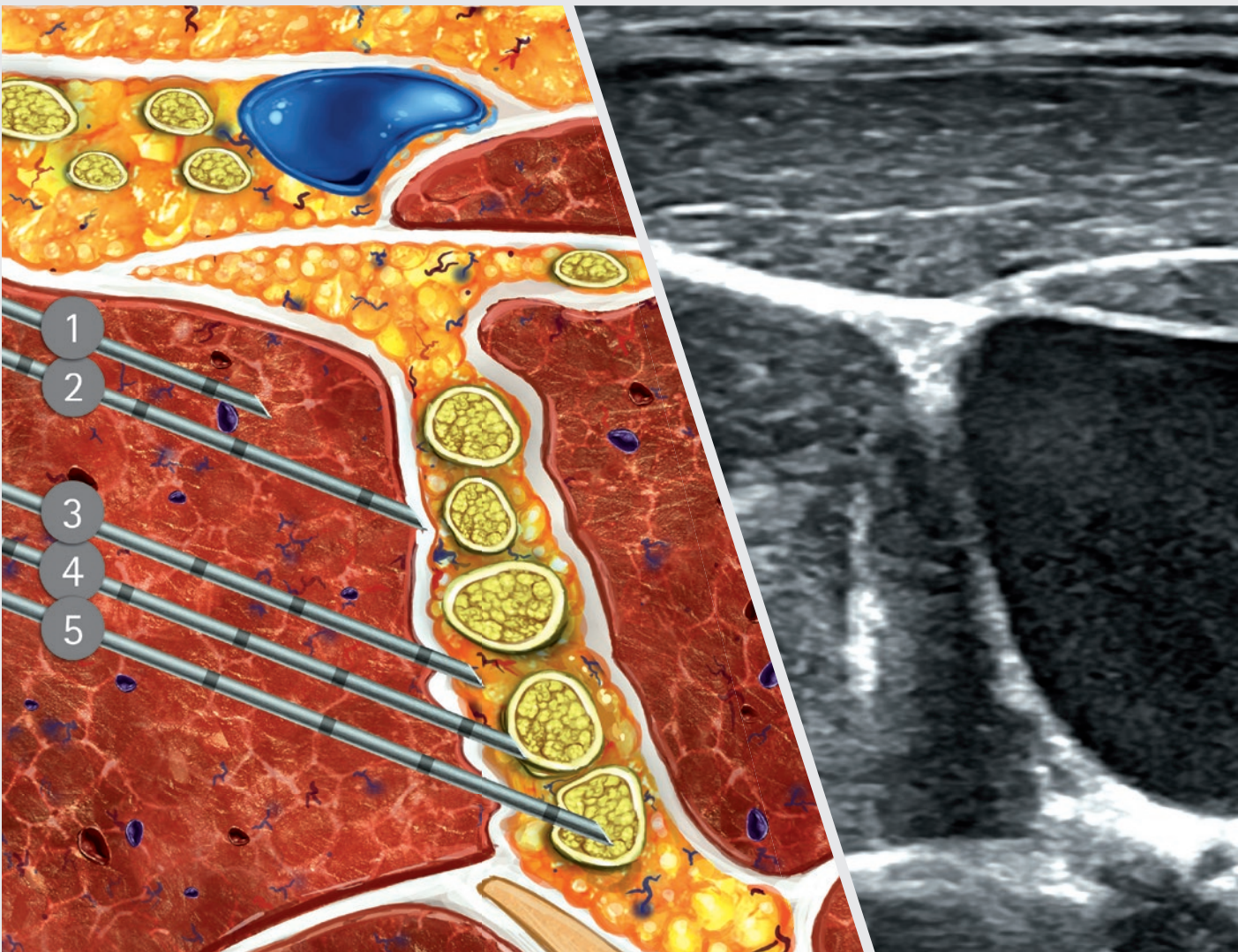
Legend: US-Ultrasound, NS-Nerve Stimulation, LA- Local Anesthetic, Low Injection Pressure < 15psi \*

\* Experimental studies in large models/human cadavers suggest that opening pressure for intrafascicular injection requires > 15psi






† Experimental studies suggest that EMR at < 0.2 mA (0.1 ms) indicates intraneural needle placement; for additional safety margin, 0.5 mA is recommended in the guidelines by the collaborative group

# How it works

## For Interscalene Brachial Plexus Block



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	Needle tip position	Ultrasound	Nerve Stimulation	Opening Injection Pressure
1	Needle tip intramuscularly	Visual feedback, influenced by image-quality, patients sono-anatomy; highly user-dependent <sup>6</sup>	Local muscle twitch may be present, indicating intramuscular needle tip position	Non-specific; typically < 15psi 
2	Needle tip placed against fascia (scalene sheath contact)		Local and/or distal motor response may be present	Typically high (> 15psi) as needle bevel is obstructed by the fascia 
3	Needle placed in interscalene space		When present, distal motor response may occur at 0.5 mA, indicating proper needle placement	Low (< 15psi) as injection occurs into loose connective tissue perineurally <sup>1</sup> 
4	Needle-nerve-contact (brachial plexus root)		Distal motor response may be present at ≤ 0.5 mA <sup>1,8,10,11</sup>	High (> 15psi) as the bevel of the needle is occluded by the connective tissue <sup>1</sup> 
5	Needle tip placed in the root of the brachial plexus		Distal motor response commonly present at ≤ 0.5 mA <sup>5</sup>	High (> 15psi) as injection into fascicles requires higher opening pressure <sup>1,4</sup> 



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- <sup>2</sup> Kapur et al. Neurologic and histologic outcome after intraneural injections of lidocaine in canine sciatic nerves. *Acta Anaesthesiol Scand*, 2007; 51:101-7
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- <sup>4</sup> Orebaugh et al. Brachial plexus root injection in a human cadaver model: Injectate distribution and effects on the neuraxis. *Reg Anesth Pain Med*, 2012; 37(5):525-9
- <sup>5</sup> Bigeleisen et al. Extraneural versus intraneural stimulation thresholds during ultrasound-guided supraclavicular block. *Anesthesiology*, 2009; 110(6):1235-43
- <sup>6</sup> Sites et al. Characterizing novice behavior associated with learning ultrasound-guided peripheral regional anesthesia. *Reg Anesth Pain Med*, 2007; 32(2):107-15
- <sup>7</sup> Chan et al. An ultrasonographic and histological study of intraneural injection and electrical stimulation in pigs. *Anesth Analg*, 2007; 104(5):1281-4
- <sup>8</sup> Voelckel et al. Signs of inflammation after sciatic nerve block in pigs. *Anesth Analg*, 2005; 101:1844-6
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- <sup>11</sup> Tsai et al. Intensity of the stimulating current may not be a reliable indicator of intraneural needle placement. *Reg Anesth Pain Med*, 2008; 33(3):207-10
- <sup>12</sup> Neal et al. The ASRA evidence-based medicine assessment of ultrasound-guided regional anesthesia and pain medicine: Executive summary. *Reg Anesth Pain Med*, 2010; 35:S1-9
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## Additional relevant literature

- Claudio et al. Injection pressures by anesthesiologists during simulated peripheral nerve block. *Reg Anesth Pain Med*, 2004; 29(3):201-5
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