ABSTRACT:

**Audience:** This ultrasound-guided regional anesthesia elective is designed for emergency medicine residents.

**Length of Curriculum:** The proposed length of this curriculum is over one week.

**Introduction:** Ultrasound-guided regional anesthesia (UGRA) is a useful tool in the emergency department (ED) for managing painful conditions, and many programs have identified that these are useful skills for emergency providers; however, only about 53% of programs report teaching UGRA as part of their core curriculum, and there currently are no widely available or peer reviewed nerve block curricula designed for emergency medicine residents.

**Educational Goals:** To deliver an immersive 1-week elective to provide residents a strong foundation in principles of UGRA and an introduction to 14 nerve block procedures applicable to care provided in the ED.

**Educational Methods:** The educational strategies used in this curriculum include: instructional videos, written and online independent learning materials, one-on-one teaching at the bedside with an emergency ultrasound fellow, simulation of nerve block techniques using a femoral nerve block task trainer, and performance of supervised nerve block procedures on patients in the ED.

**Research Methods:** All residents provided feedback through an online survey after completing the elective.

**Results:** Eight residents completed the elective in the first year of implementation. Following completion of the UGRA curriculum, 8/8 (100%) of residents reported increased level of confidence in performing UGRA. In addition, 8/8 (100%) of residents reported they were “likely” or “very likely” to incorporate UGRA into their
future EM practice. All 8 (100%) residents responded they were “very likely” to recommend the elective to other trainees. The elective received high ratings for overall quality with an average rating of 9.4 out of 10 (±0.7).

Discussion: An elective in ultrasound-guided regional anesthesia can be successfully incorporated into an emergency medicine training program. The curriculum was successful in providing focused training in UGRA and resulted in increased resident confidence in performing nerve block procedures.

Topics: Ultrasound-guided regional anesthesia, nerve block, resident, elective, pain.
Brief introduction:
Effective pain management is a cornerstone of emergency medicine (EM) practice. EM physicians must utilize a variety of pain management techniques, including ultrasound-guided regional anesthesia (UGRA). Ultrasound-guided regional anesthesia utilizes real-time ultrasound guidance for needle placement near a peripheral nerve or in a fascial plane such that injection of anesthetic results in sensory blockade of a particular anatomic area. There are many potential advantages to using UGRA over conventional pain management techniques, including avoiding common and potentially dangerous side effects of opioid-based systemic analgesia and risks of procedural sedation. Ultrasound-guided regional anesthesia can provide effective short-term pain control to facilitate procedures such as reduction and splinting of fractures. The most well-studied applications of UGRA in the Emergency Department (ED) are the femoral nerve and fascia iliaca blocks for acute hip fractures. In addition to effective pain control the femoral nerve block has been shown to reduce complications, such as pneumonia in elderly patients, and improve long-term functional outcomes.

Problem identification, general and targeted needs assessment:
Despite the benefits of UGRA, many EM residents do not receive focused education in performing ultrasound-guided nerve blocks. In a study of residency programs in the United States, nearly all respondents believed that UGRA was a necessary skill for all EM physicians to learn; however, only 53% of residency training programs reported teaching UGRA as part of their core ultrasound curriculum. While a number of textbook and online resources exist, including a web-based tutorial for anesthesia residents and a recent review, there is no UGRA curriculum available to EM residents. Nearly all EM trainees in the United States complete a rotation dedicated to instruction in bedside ultrasound and attain basic ultrasound skills. Studies have shown that EM residents, after acquiring basic ultrasound skills, can perform individual nerve blocks effectively after minimal instruction. An elective specifically designed for EM trainees addresses this gap in training and ensures that future EM physicians are proficient in these important techniques.

The curriculum was designed as a 1-week elective rotation during the PGY2 through PGY4 year, after residents had completed a one-week introductory ultrasound rotation during their PGY1 year. A literature search was performed, open access UGRA resources were reviewed, including the New York School of Regional Anesthesia (NYSORA) website as well as the Highland Emergency Medicine Residency Ultrasound website. We compiled an extensive list of nerve block techniques and selected those most relevant to EM practice. An expert panel of

USER GUIDE

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Learner Audience:
Junior Residents, Senior Residents

Length of Curriculum:
1 week

Topics:
Ultrasound-guided regional anesthesia, nerve block, resident, elective, pain.

Objectives:
By the end of this elective learners will be able to:
1. Know the uses and indications for the 14 UGRA techniques described in this elective.
2. Describe the contraindications to performing nerve block procedures.
3. Identify the key anatomic landmarks for each nerve block procedure using ultrasound on models or patients in the ED.
4. Learn maximum allowable doses, duration of action, and uses for commonly used local anesthetic medications.
5. Recognize the signs and symptoms of local anesthetic systemic toxicity (LAST) as well as appropriate management of this condition and indications for Intralipid.

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ultrasound fellowship trained EM physicians reviewed the list of techniques and additional techniques were solicited. The panel was comprised of ultrasound experts from multiple institutions across the United States who practiced in both academic and community settings. They agreed on a final list of 14 techniques (Table 1).

Table 1: Nerve Block Procedures

| Superficial Cervical Plexus Plane Block | Anterior Scalene Brachial Plexus Block |
| Supraclavicular Brachial Plexus Block | Infraclavicular Brachial Plexus Block |
| Axillary (Deltoid) Nerve Block | Serratus Anterior Plane Block |
| Radial Nerve Block | Median Nerve Block |
| Ulnar Nerve Block | Popliteal Sciatic Nerve Block |
| Saphenous Nerve Block | Posterior Tibial Nerve Block |
| Transversus Abdominis Plane Block | |
| Retroclavicular Approach to the Infraclavicular Region (RAPTIR) Brachial Plexus Block | |

Goals of the curriculum:
Provide an immersive elective educational experience for EM residents. Residents will focus on the key principles of UGRA and gain experience in 14 nerve blocks commonly performed in the ED.

Objectives of the curriculum:
By the end of this elective learners will be able to:
1. Know the uses and indications for the 14 UGRA techniques described in this elective.
2. Describe the contraindications to performing nerve block procedures.
3. Identify the key anatomic landmarks for each nerve block procedure using ultrasound on models or patients in the ED.
4. Learn maximum allowable doses, duration of action, and uses for commonly used local anesthetic medications.
5. Recognize the signs and symptoms of local anesthetic systemic toxicity (LAST) as well as appropriate management of this condition and indications for Intralipid.

Educational strategies:
The curriculum chart below details our educational strategies, content, learning objectives, intended learners, requirements, and targeted milestones.

Results and tips for successful implementation:
Before the start of the elective, we provided residents with the elective syllabus, a detailed table of all nerve block techniques covered in the course, and a list of print and online resources organized by nerve block technique. The elective educational experience included one-on-one teaching at the bedside with a fellow, simulation of nerve block technique using a femoral nerve block task trainer, and performing fellow-supervised nerve block procedures on patients in the ED. Each resident met with a fellow in the ED for a minimum of three one-on-one sessions, each session scheduled for 2 hours.

Between December 2018 and June 2019, 8 total residents completed the elective. Three PGY2 residents, 2 PGY3 residents and 3 PGY4 residents completed the elective. All residents provided feedback through an online survey after completing the elective. Data collection was given exempt status by our Institutional Review Board. The residents had minimal previous experience with UGRA. 7/8 (87.5%) residents had performed or directly observed 5 or fewer nerve block procedures before the elective. Following completion of the UGRA elective, 8/8 (100%) residents reported increased level of confidence in performing UGRA. 8/8 (100%) residents also reported they were “likely” or “very likely” to incorporate UGRA into their future EM practice. All residents responded they were “very likely” to recommend the elective to other trainees. The elective received high ratings for overall quality with an average rating of 9.4 out of 10 (±0.7). In free text responses, all residents cited a strength of the elective was one-on-one experience performing UGRA with the fellow. Four residents responded that more opportunities to perform ultrasound-guided nerve blocks on patients would improve the elective.

Associated content:
There are recorded video lectures for each nerve block procedure covered in the elective.

Evaluation and feedback:
Following initial implementation of the curriculum, we received feedback that residents desired more hands-on practice in performing nerve block procedures. We addressed this need by incorporating a femoral nerve block task trainer to simulate a nerve block procedure from start to finish. We also moved one-on-one scanning sessions in the ED from the morning to the afternoon and early evening when more opportunities to perform nerve block procedures on patients were available.

We also received feedback that the provided list of online resources could be supplemented with additional content for each nerve block procedure. In response, we recorded an introductory lecture, 5 to 15 minutes in duration, for each procedure and provided these to residents before their scheduled rotation. Residents reported in their evaluation surveys that these were a useful addition to the curriculum.
References/further readings:

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10. Highland EM Ultrasound Fueled Pain Management [Internet]. California: Highland Emergency Medicine; 2018 [cited 2018 Dec 1]. Available from: http://highlandultrasound.com/test

11. Micheller D, Chapman MJ, Cover M, et al. A low-fidelity, high-functionality, inexpensive ultrasound-guided nerve block model. *CJEM.* 2017;19(1):58-60. doi: 10.1017/cem.2016.335
# Curriculum Chart

| Topic | Recommended Educational Strategy | Educational Content | Objectives | Learners | Timing, Resources Needed | Recommended Assessment, Milestones Addressed |
|-------|----------------------------------|---------------------|------------|----------|--------------------------|---------------------------------------------|
| **Principles of Ultrasound-Guided Regional Anesthesia (UGRA)** | 1. Brief introductory lecture | - Performing UGRA safely  
- Potential benefits of nerve blocks to patients and providers  
- Indications and contraindications to nerve block procedures  
- Correct anesthetic dosing and calculation of maximum allowable dose  
- Local anesthetic systemic toxicity  
- Intralipid use and dosing  
- Sterile technique  
- Elective educational resources | The learner will receive an introduction to the elective curriculum structure, elective resources, and the key principles of performing UGRA | PGY2-PGY4 | 15 minutes (lecture)  
Instructors: 1  
Equipment: PowerPoint and laptop/screen  
15 minutes (Overview and Q+A)  
Instructors: 1  
Equipment: Elective syllabus, Block Matrix, and Resources documents | Assessment: Learner demonstrates mastery of principles through direct observation of nerve block procedures on task trainer and patients |
| **Femoral Nerve Block Simulation Session** | Directly observed procedure simulation | - Necessary materials to perform nerve block procedure and where to obtain  
- Sterile technique  
- Needle tracking skills with ultrasound using long-axis technique | Learner will show proper technique in performing a nerve block procedure on a task trainer meant to simulate a femoral nerve block using sterile technique | PGY2-PGY4 | 45 minutes  
Instructors: 1  
Equipment: femoral nerve block task trainer, ultrasound machine, block needle/spin-al needle, syringes, sterile tubing, saline, sterile gloves, Chloraprep and sterile ultrasound probe cover | Assessment: Direct observation of procedure technique |
## Didactics and Hands-on Curriculum

| Topic                                           | Recommended Educational Strategy | Educational Content                                                                 | Objectives                                                                 | Learners | Timing, Resources Needed                                                                 | Recommended Assessment, Milestones Addressed |
|------------------------------------------------|----------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------|----------|------------------------------------------------------------------------------------------|---------------------------------------------|
| One-on-One Scanning Sessions in the ED          | Hands-on teaching at the bedside | - Identification of the key anatomic landmarks for each nerve block procedure       | Learner will describe how to obtain ultrasound images for each nerve block procedure, how to position the patient for procedure success, and the optimal needle approach | PGY2-PGY4| 2-hour sessions Instructors: 1 per 2 residents maximum Equipment: ultrasound machine, patients in the ED willing to consent to an educational ultrasound exam | Assessment: Direct observation of ultrasound images obtained with real-time feedback |
| Performance of Nerve Block Procedures in the ED | Hands-on ultrasound teaching at the bedside | - Selection of patients with indications for nerve blocks and no contraindications | Learner will demonstrate performance of an entire nerve block procedure on an ED patient, from patient selection to documentation of the procedure | PGY2-PGY4| 2-hour sessions Instructors: 1 per 2 residents maximum Equipment: ultrasound machine, materials for nerve block procedure, ED patients with conditions with indications for nerve block procedure who are able to consent | Assessment: Direct observation of procedure performance with real-time feedback |
# DIDACTICS AND HANDS-ON CURRICULUM

| Topic                          | Recommended Educational Strategy                      | Educational Content                                                                 | Objectives                                                                                                                                                                                                 | Learners | Timing, Resources Needed | Recommended Assessment, Milestones Addressed |
|-------------------------------|--------------------------------------------------------|---------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|--------------------------|---------------------------------------------|
| Nerve Block Procedure         | Introductory lectures covering each nerve block procedure | - Skin, muscular, and bony territory anesthetized by each nerve block procedure        | The learner will describe the anatomical area anesthetized, clinical uses, key anatomy on ultrasound images, optimal patient positioning and needle trajectory, and anesthetic dose/volume for each nerve block procedure                                                                 | PGY2-PGY4 | 5 to 15 minutes for each lecture, 12 total lectures | Assessment: Knowledge is tested during one-on-one scanning sessions by the instructor |
| Recorded Video Lectures       |                                                        | - Examples of common conditions for which each nerve block procedure would be useful    |                                                                                                                                                                                                          |          |                          |                                             |
|                               |                                                        | - Ultrasound images and clips with important anatomy highlighted for identification    |                                                                                                                                                                                                          |          |                          |                                             |
|                               |                                                        | - Photographs showing patient positioning, positioning of ultrasound probe, and needle approach |                                                                                                                                                                                                          |          |                          |                                             |
|                               |                                                        | - Animations showing ideal trajectory of needle to target                               |                                                                                                                                                                                                          |          |                          |                                             |
|                               |                                                        | - Description of the required anesthetic dose and volume needle to achieve adequate block |                                                                                                                                                                                                          |          |                          |                                             |
|                               |                                                        | - List of references for further reading                                               |                                                                                                                                                                                                          |          |                          |                                             |

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Appendix A: Ultrasound Guided Regional Anesthesia Elective

Description:
This is a one-week elective providing instruction on ultrasound-guided nerve blocks useful to the emergency physician. Residents will complete a curriculum that includes independent study and hands-on learning of nerve block techniques. Ultrasound fellows and faculty will teach the elective.

Objectives:
1. Learn the uses and indications for common ED blocks as well as the contraindications to performing these procedures.
2. Identify relevant anatomy using ultrasound for common ED nerve blocks.
3. Develop and improve skill/technique for ultrasound guided needle placement.
4. Learn maximum doses, duration of action, indications, and contraindications for commonly used local anesthetics, signs/symptoms of local anesthetic systemic toxicity (LAST), and appropriate treatment and indications for Intralipid.

List of selected nerve blocks to learn during elective:
1. Femoral Nerve/Fascia Iliaca Block
2. Forearm Nerve Blocks (Median, Radial, Ulnar)
3. Brachial Plexus Nerve Blocks (Interscalene, Supraclavicular, Infraclavicular)
4. RAPTIR Nerve Block (Retroclavicular approach for infraclavicular brachial plexus)
5. Superficial Cervical Plexus Block
6. Axillary Nerve Block
7. Serratus Plane/Pectoralis Nerve Block
8. Transverse Abdominis Plane (TAP) Block
9. Saphenous Nerve Block
10. Popliteal Sciatic Nerve Block
11. Posterior Tibial Nerve Block

Activities to complete:
- Independent study of nerve block procedures using below resources
- Identify anatomy using US in ED and review images with US fellow/faculty
- Rehearse nerve block procedure using models
- Perform nerve blocks if available in the ED

Resources:
1. Website guide to quickly review a block procedure.
   a. Highland Ultrasound: http://highlandultrasound.com/
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2. In-depth Website guide to block procedures.
   a. NYSORA – New York School of Regional Anesthesia: www.nysora.com

3. iBook Textbook Chapters: Introduction to Bedside Ultrasound
   a. Volume 1 (Brachial Plexus Blocks – Interscalene, Supraclavicular, Infraclavicular, Axillary): https://itunes.apple.com/us/book/introduction-to-bedside-ultrasound/id554196012?mt=11
   b. Volume 2 (Femoral, Forearm Blocks): https://itunes.apple.com/us/book/introduction-to-bedside-ultrasound/id647356692?mt=11

4. Short Instructional Videos – TAP, Superficial cervical plexus, Ulnar nerve, Popliteal sciatic nerve, Median nerve, Radial nerve, Supraclavicular brachial plexus, interscalene brachial plexus, posterior tibial nerve, Fascia Iliaca compartment block.
   a. 5 Minute Sono: http://5minsono.com/vids/

5. Podcasts for specific blocks
   a. Ultrasound Podcast - has a post on many of the above blocks: http://www.ultrasoundpodcast.com/?s=block

6. Block GuRu Lite – iPhone app reference, costs $6.99.

Suggested Literature:

Wilson C. Feeling Blocked? Another Pain Management Tool in the Emergency Department. Ann. Emerg Med. 2018; 72: 120-126.

Morrison RS, Dickman E, Hwang U, et al. Regional Nerve Blocks Improve Pain and Functional Outcomes in Hip Fracture: A Randomized Controlled Trial. Journal of the American Geriatrics Society. December 2016; Vol 64; No. 12: 2423-2439.

Blaivas M, Adhikari S, Lander L. A Prospective Comparison of Procedural Sedation and Ultrasound-guided Interscalene Nerve Block for Shoulder Reduction in the Emergency Department. Academic Emergency Medicine. 2011; 18: 922-927.

Liebmann O, Price D, Mills C, et al. Feasibility of Forearm Ultrasonography-Guided Nerve Blocks of the Radial, Ulnar, and Median Nerves for Hand Procedures in the Emergency Department. Ann. Emerg. Med. 2006; 48: 558-562.

Stone MB, Wang R, Price DD. Ultrasound-guide supraclavicular brachial plexus nerve block versus procedural sedation for the treatment of upper extremity emergencies. American Journal of Emergency Medicine. 2008; 26: 706-710.
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Cao D, Heard K, Foran M, Koyfman A, et al. Intravenous Lipid Emulsion in the Emergency Department: A Systematic Review of Recent Literature. *Journal of Emergency Medicine*. 2015; 48: 387-397.

Barrington MJ, Kluger R. Ultrasound guidance reduces the risk of local anesthetic systemic toxicity following peripheral nerve blockade. *Reg. Anesth Pain Med*. 2013; 38(4): 289-299.
Appendix B:
Nerve Block Matrix – Ultrasound Guided Regional Anesthesia Elective

| Block                              | Indications                                                                 | Distribution                                      | Probe Position                                                                      | Volume  |
|------------------------------------|-----------------------------------------------------------------------------|--------------------------------------------------|-------------------------------------------------------------------------------------|---------|
| Interscalene Brachial Plexus       | Shoulder dislocation, deltoid laceration (lac)/abscess, proximal/mid humerus fx | Shoulder, lateral arm, lateral forearm/hand      | Transverse on neck, 3-4cm superior to clavicle, post. to internal jugular          | 7-15 mL |
| Supraventricular Brachial Plexus   | Distal humerus fx, elbow dislocation, lac/burn/abscess distal arm/forearm    | Lateral arm, entire arm and hand distal to elbow  | Transverse just superior to mid-clavicle                                             | 20-25 mL|
| Infraclavicular Brachial Plexus    | Distal humerus fx, elbow dislocation, lac/burn/abscess distal arm/forearm    | Lateral arm, entire arm and hand distal to elbow  | Inferior to clavicle, sagittal, just medial to coracoid process                    | 25-35 mL|
| Retroclavicular approach for Infraclavicular Brachial Plexus (RAPTIR) | Distal humerus fx, elbow dislocation, lac/burn/abscess distal arm/forearm | Lateral arm, entire arm and hand distal to elbow  | Inferior to clavicle, sagittal, just medial to coracoid process                    | 25-35 mL|
| Deltoid                            | Abscess/lac over the deltid                                                | Lateral shoulder                                 | Sagittal, posterior arm 4cm inferior to the acromion                               | 5-10 mL |
| Median                             | Lac medial palm, fx 2\textsuperscript{nd} or 3\textsuperscript{rd} digits   | Palmar hand, medial 1\textsuperscript{st} digit through lateral 4\textsuperscript{th} digit | Transverse, middle of forearm                                                      | 2-5 mL  |
| Block                  | Indications                                      | Distribution            | Probe Position                                                                 | Volume  |
|-----------------------|-------------------------------------------------|-------------------------|---------------------------------------------------------------------------------|---------|
| Ulnar                 | Lac medial hand, fx 4<sup>th</sup> or 5<sup>th</sup> digits | Medial hand             | Transverse on medial forearm, identify ulnar artery and trace proximal          | 2-5 mL  |
| Radial                | Lac posterior hand, fx 1<sup>st</sup> through 4<sup>th</sup> digits | Volar hand, 1<sup>st</sup> through medial 4<sup>th</sup> digit | Transverse on lateral arm, identify artery and trace proximal/Transverse proximal to lateral epicondyle | 2-5 mL  |
| Femoral/Fascia iliaca | Femur fx                                        | Hip, medial thigh, medial leg, medial ankle/foot | Transverse in femoral crease                                                    | 10-30 mL|
| Saphenous             | Lac or abscess on medial leg or foot             | Medial distal thigh through medial foot | Transverse on anteromedial thigh                                                 | 5-10 mL |
| Popliteal Sciatic     | Fx distal tib/fib, lac or abscess lower leg      | Lower leg/ankle/foot, excluding medial leg/ankle | Transverse of popliteal fossa, trace proximally                                 | 15 – 20 mL|
| Posterior Tibial      | Lac to sole of foot, FB in sole of foot          | Majority of sole of the foot excluding extreme medial and lateral | Transverse, just proximal to medial malleolus, trace proximally                 | 3 – 5 mL|
| Superficial cervical plexus (Plane Block) | Lac lower ear, central line placement, distal clavicle fx, lac/abscess anterolateral neck | Anterolateral neck, ante-auricular and retroauricular areas, skin overlying clavicle | Transverse over midpoint of SCM (sternocleidomastoid) muscle (posterior border)  | 5 – 15 mL|
| Serratus Anterior (Plane Block) | Rib fx, chest tube placement                     | Anterolateral chest, T3-T9 dermatomes | Sagittal, between 4<sup>th</sup> and 5<sup>th</sup> ribs, anterior axillary line | 20 - 30 mL|
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| Block                          | Indications                  | Distribution                          | Probe Position                                      | Volume       |
|--------------------------------|------------------------------|---------------------------------------|----------------------------------------------------|--------------|
| Transversus Abdominis (Plane Block) | Abdominal wall abscess, abdominal wall lac | Hemi-abdomen, T10-T12 dermatomes | Transverse, mid-axillary line, proximal to iliac crest, lower abdomen | 20 – 30 mL   |

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Appendix C:
Ultrasound Guided Regional Anesthesia Elective Resource List

1. Interscalene Brachial Plexus
   a. NYSORA - https://www.nysora.com/techniques/upper-extremity/interscalene/ultrasound-guided-interscalene-brachial-plexus-block/
   b. Introduction to Bedside Ultrasound: Chapter 11
   c. 5 Min Sono - http://5minsono.com/is/

2. Supraclavicular Brachial Plexus
   a. NYSORA – https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/upper-extremity-regional-anesthesia-for-specific-surgical-procedures/anesthesia-and-analgesia-for-elbow-and-forearm-procedures/ultrasound-guided-supraclavicular-brachial-plexus-block/
   b. Introduction to Bedside Ultrasound: Chapter 11
   c. 5 Min Sono - http://5minsono.com/supraclav/

3. Infraclavicular Brachial Plexus
   a. NYSORA - https://www.nysora.com/techniques/upper-extremity/infrACLavicular/
   b. Introduction to Bedside Ultrasound: Chapter 11

4. Retroclavicular approach to Infraclavicular Brachial Plexus (RAPTIR)
   a. Highland Ultrasound - http://highlandultrasound.com/raptir/
   b. Review Paper - Luftig J, Mantuani D, Herring AA, Nagdev A. Ultrasound-guided retroclavicular approach infraclavicular brachial plexus block for upper extremity emergency procedures. AJEM. 2017; 35(5): 773-777.
   c. ACEP Now - https://www.acepnow.com/article/how-to-effectively-block-an-acutely-fractured-distal-radius/

5. Axillary
   a. Highland Ultrasound - http://highlandultrasound.com/axillary-nerve-delt/

6. Median
   a. Highland Ultrasound - http://highlandultrasound.com/forearm-blocks/
   b. Introduction to Bedside Ultrasound: Chapter 21, Section 3
   c. 5 Min Sono - http://5minsono.com/mnb/
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7. Ulnar
   a. Highland Ultrasound - http://highlandultrasound.com/forearm-blocks/
   b. Introduction to Bedside Ultrasound: Chapter 21, Section 3
   c. 5 Min Sono - http://5minsono.com/unb/

8. Radial
   a. Highland Ultrasound - http://highlandultrasound.com/forearm-blocks/
   b. Introduction to Bedside Ultrasound: Chapter 21, Section 3
   c. 5 Min Sono - http://5minsono.com/rnb/

9. Femoral/Fascia Iliaca
   a. NYSORA - https://www.nysora.com/techniques/lower-extremity/ultrasound-guided-femoral-nerve-block/
   b. Introduction to Bedside Ultrasound: Chapter 20
   c. Highland Ultrasound - http://highlandultrasound.com/femoral-block/

10. Saphenous
    a. Highland Ultrasound - http://highlandultrasound.com/saphenous-block/
    b. NYSORA - https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/lower-extremity-regional-anesthesia-for-specific-surgical-procedures/foot-and-ankle/ultrasound-guided-saphenous-subtarsus-adductor-canal-nerve-block/

11. Popliteal Sciatic
    a. 5 Min Sono - http://5minsono.com/pop/
    b. NYSORA - https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/lower-extremity-regional-anesthesia-for-specific-surgical-procedures/foot-and-ankle/ultrasound-guided-popliteal-sciatic-block/

12. Posterior Tibial
    a. 5 Min Sono - http://5minsono.com/ptnb/
    b. Highland Ultrasound - http://highlandultrasound.com/posterior-tibial-block/

13. Superficial Cervical Plexus Plane
    a. 5 Min Sono - http://5minsono.com/scp/
    b. Highland Ultrasound - http://highlandultrasound.com/superficial-cervical-plexus-block/

14. Serratus Anterior Plane
    a. NYSORA - https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/thorax/pectoralis-serratus-plane-blocks/
    b. Highland Ultrasound - http://highlandultrasound.com/rib-fractures/
DIDACTICS AND HANDS-ON CURRICULUM

15. Transversus Abdominis Plane (TAP)
   a. 5 Min Sono - http://5minsono.com/tap/
   b. NYSORA - https://www.nysora.com/regional-anesthesia-for-specific-surgical-procedures/abdomen/ultrasound-guided-transversus-abdominis-plane-quadratus-lumborum-blocks/
## DIDACTICS AND HANDS-ON CURRICULUM

Tucker R V, et al. An Ultrasound-Guided Regional Anesthesia Elective for Emergency Medicine Residents. JETem 2021. 6(1):C1-34. [https://doi.org/10.21980/J8TP9B](https://doi.org/10.21980/J8TP9B)

Highland EM Ultrasound Fueled Pain Management. [http://highlandultrasound.com/med-guid](http://highlandultrasound.com/med-guid)

| Drug                  | Dose (mg/kg) | 50 kg (ml) | 70 kg (ml) | 90 kg (ml) | Max Dose | Notes |
|-----------------------|--------------|------------|------------|------------|----------|-------|
| Ropivacaine 1% (10mg/ml) | 3mg/kg       | 150mg (15ml) | 210mg (21ml) | 270mg (27ml) | 300mg (30ml) | Dilute 1% solution 1:1 with NS. S-bi+iv block, powerful, have intralipid! |
| Bupivacaine 0.5% (5mg/ml)   | 2 mg/kg    | 100mg (20ml) | 140mg (28ml) | 175mg (35ml) | 175mg / 35 ml | greater risk of toxicity than lidocaine. contraindicated in pregnancy. |
| Lidocaine 1% (10mg/ml)      | 4 mg/kg     | 200mg (20ml) | 280mg (28ml) | 300 mg (30ml) | 300mg / 30 ml | Do not repeat within 2 hours. |
| Lidocaine 1% w/epi (10mg/ml) | 7 mg/kg   | 350mg (35ml) | 490mg (49ml) | 500mg (50ml) | 500mg/50 ml | OK to use on face, penis, digits if no peripheral vascular disease. |
| Mepivacaine 1.5% (15mg/ml)  | 4 mg/kg     | 200mg (13.3ml) | 280mg (18.6ml) | 300 mg (20ml) | 300mg/20 ml | contraindicated in pregnancy. |
| Chloroprocaine 3% (30mg/ml) | 11mg/kg    | 500mg (16.6 ml) | 700mg (23.3ml) | 900mg (30ml) | 1000mg/33ml | ultra short blocks (60-90cm), pregnancy safe. |

Lyons/Herring 2016
### Guidelines for Emergency Regional Anesthesia for Trauma Orthopedic Injuries

#### Block OK
- Shoulder dislocation
- Clavicle fracture
- Proximal humerus fracture
- Low energy distal radius fracture
- Hand and digit injuries
- Hip fracture and dislocation
- Low energy foot and ankle fractures

*Contact orthopedic surgery as soon as possible for any patients to be admitted or patients who will require in ED consultation, but do not delay block placement.*

#### Universal precautions
- Appropriate splinting, protection, icing of any injured extremity.
- Appropriate analgesic administration.
- Block placement should not delay other time sensitive interventions.
- Appropriate consideration of and patient discussion of the risks and benefits of any block.
- Documentation of consent.
- Thorough, detailed, and appropriately documented neurologic exam before block is performed.
- Thorough, detailed, and appropriately documented compartment exam before block is performed.
- Safe and sterile procedural technique appropriately documented including but not limited to: pre-procedure timeout with confirmation correct patient, indication, and side; appropriate patient monitoring; use of real-time ultrasound-guidance with avoidance of needle to nerve contact and vascular puncture; aspiration and small volume (3-5mL) injection of appropriately dosed local anesthetic.
- Presence of necessary resuscitation equipment and intralipid in case of local anesthetic toxicity reaction.
- Clear marking of blocked extremity and documentation of block details in the medical record.
- Verbal communication of block details with participating clinical teams prior to discharge or transfer from ED.
- Appropriate post block care of weakened or insensate extremity to prevent falls and limb injury.

#### Block after Consultation
- Humeral shaft fracture
- Elbow fracture
- Both bone forearm fracture
- Femoral shaft fracture

*Perform and document detailed neurologic exam and consult with orthopedic service before block is placed.*

#### No Block
**High risk for compartment syndrome**
- Tibial fracture
- High emergency forearm fracture
- High Energy foot fracture
- Any injury with evidence of neurovascular injury or clinical concern for a possible compartment syndrome

*Perform block only after requested by Trauma and Orthopedic service attending.*
Appendix D:
Elective Assessment – Ultrasound Guided Regional Anesthesia Elective

Consent
By completing this assessment, you agree to be enrolled in a study to assess the effectiveness of the elective. You do not have to complete this assessment and have the right to refuse participation. Refusing to participate will in no way affect your standing in the residency. No personal information will be collected, and responses are anonymous. If you have questions, contact XXX, MD at XXX@XXX. All feedback on how to improve the elective experience is greatly appreciated.

I Agree
I Decline

1. What is your current level of training?
   - EM1
   - EM2
   - EM3
   - EM4

2. Before completing the elective, how many nerve block procedures had you performed or directly observed?
   - 0
   - 1-3
   - 3-5
   - 5 or more

3. Before completing the elective, what was your level of confidence in performing nerve block procedures?
   - Extremely confident
   - Very confident
   - Somewhat confident
   - Not so confident
   - Not at all confident
4. After completing the elective, what is your level of confidence in performing nerve block procedures?

   Extremely confident
   Very confident
   Somewhat confident
   Not so confident
   Not at all confident

5. How likely are you to recommend this elective to other residents?

   Extremely likely
   Somewhat likely
   Neither likely nor unlikely
   Somewhat unlikely
   Extremely unlikely

6. Please rate the elective experience overall.

   1 – Poor
   2
   3
   4
   5 – Good
   6
   7
   8
   9
   10 – Excellent

7. What are the most positive aspects of the elective experience?
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8. How can the elective experience be improved?

9. Please provide any additional feedback on the elective.

Thank you very much for completing this elective assessment.
Appendix E:
Introduction to Ultrasound Guided Nerve Blocks

Please see associated lecture

Lecture Link: https://youtu.be/Bp9EwDXKK_A
Appendix F:
Femoral and Facia Iliaca Blocks

Please see associated lecture
Lecture Link: https://youtu.be/9FnS0ZOvh6o
Appendix G: Forearm Nerve Blocks

Please see associated lecture

Lecture Link: https://youtu.be/4wTISU4156I
Appendix H:
Brachial Plexus Nerve Blocks

Interscalene

Brachial Plexus Nerve Block

Please see associated lecture
Lecture Link: https://youtu.be/TOrKoTcuZc8
Appendix I: RAPTIR Block

Please see associated lecture

Lecture Link: https://youtu.be/pZTIwxZ5E4E
Appendix J:
Superficial Cervical Plexus Block

Please see associated lecture
Lecture Link: https://youtu.be/siGBeisWC1Q
Appendix K:
Axillary Deltoid Nerve Block

Please see associated lecture

Lecture Link: https://youtu.be/_2TBXobcH1A
Appendix L:
Serratus Anterior Plane Block

Please see associated lecture
Lecture Link: https://youtu.be/E_q1yVADE6Q
Appendix M: Transverse Abdominis Plane Block

Please see associated lecture
Lecture Link: https://youtu.be/JbY-7aT8m7I
Appendix N: Saphenous Nerve Block

Please see associated lecture

Lecture Link: https://youtu.be/7HwnQonE5ok
Appendix O:
Popliteal Sciatic Nerve Block

Please see associated lecture

Lecture Link: https://youtu.be/lH1u6oPt4nY
Appendix P:
Posterior Tibial Nerve Block

Please see associated lecture
Lecture Link: https://youtu.be/3mtXyF04BC4