When blocks become botched:

Local anesthetic systemic toxicity and block-specific complications

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Disclosures

I have no relevant financial interests or conflicts to disclose.

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Objectives

- Recognize the spectrum of clinical presentations of LAST
- Gain awareness of the changing clinical setting of LAST in recent years
- Understand how the management of cardiac arrest from LAST differs from the standard ACLS algorithm
- Consider complications of interscalene and paravertebral block

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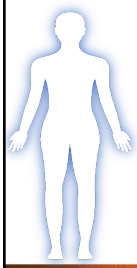
Case report



- 58yo, 82kg male presented for arthroscopic rotator cuff surgery
- PMH: CABG at 43yo; h/o angina on exertion and occasionally at rest; deemed stable on medical therapy by cardiologist
- Meds: NTG PRN, lisinopril, atenolol, clopidogrel, and aspirin

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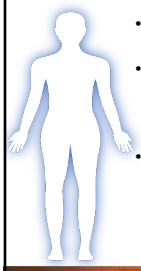
Case report



- Standard monitors placed in preop area, oxygen by NC, and 2mg midazolam and 50mcg fentanyl administered
- **Interscalene block** was performed and 40mL of local anesthetic was administered (20mL of 0.5% bupivacaine + 20mL of 1.5% mepivacaine) slowly in 5mL increments after gentle negative aspiration
- Pt **awake** and conversant during block, blood was **not** aspirated at any time

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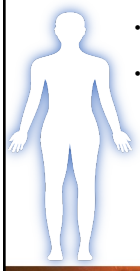
Case report



- **30 seconds** after block was placed, pt became incoherent and then developed a **tonic-clonic seizure**
- Oxygen was delivered by face mask and 50mg of propofol was injected, seizure stopped but occurred again 90 seconds later

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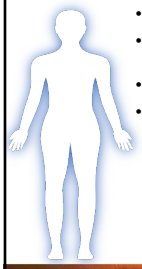
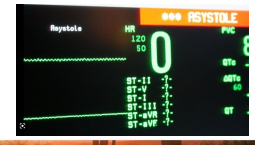
Case report



- EKG showed **asystole** and no pulse was detectable
- ACLS was initiated, trachea intubated, and pt received epi, atropine, amiodarone, vasopressin
- Shocks were administered when warranted
- Plan to initiate emergency cardiopulmonary bypass



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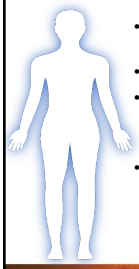
Case report



- 20 mins after initiation of code, 100mL of 20% **intralipid** was administered
- Compressions continued and a shock was administered
- Within seconds, a single beat appeared on the EKG and within 15 seconds, cardiac rhythm returned to sinus at 90 bpm and BP and pulse returned
- **Intralipid infusion** was continued for 2 hours, pt was weaned from vent, awake, responsive with no neurologic sequelae

Rosenblatt MA et al. Anesthesiology 2006

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Local Anesthetic Systemic Toxicity (LAST)

Potentially **life-threatening CV collapse** from unintentional **intravascular** injection or **slow absorption** of high dose of local anesthetic

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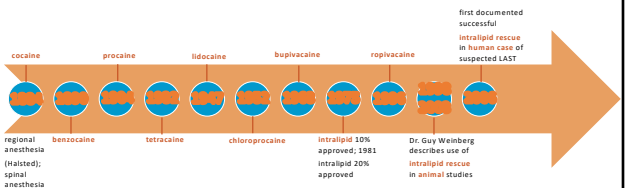
Historical perspective



Drasner K. RAPM 2010

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Intralipid

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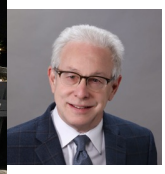
- Parti
- Iono
- Post



Slide courtesy of Dr. Ashley Shilling

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Frequency of LAST

TABLE 2. Results From Clinical Registries and Observational and Administrative Data Sets

Author, y	LAST Events, n	N	Incidence of LAST After PNB n per 1000	%	Regional Anesthesia	Setting	Presenting Features
Ecoffey et al, 2010[41]	3	18,375	0.16	0.02	Neuraxial†: 10,169 Peripheral: 18,735	Pediatric	Major LAST
Orebaugh et al, 2012[42]	6	14,505	0.41	0.04	Peripheral	Single-center academic	Major LAST
Sites et al, 2012[25]	0	12,668	—		Peripheral	Single-center academic	Events sought were seizures
Polaner et al, 2012[44]	0	14,917	0–2*		Neuraxial†: 9156 Peripheral: 5761	Pediatric, 6 academic centers	
Barrington and Kluger, 2013[45]	22	25,336	0.87	0.09	Peripheral	Multi-center, Academic, Community Hospitals	Minor LAST, 13; Major LAST, 8, Cardiac Arrest, 1
Rohrbaugh et al, 2013[26]	8	15,014	0.53	0.05	Interscalene		Major LAST
Gurnaney et al, 2014[5]	3	1,954	1.53	0.2	Peripheral	Pediatric single-center academic	Outpatient catheters, minor LAST
Heinonen et al, 2015[47]	14	38,350	0.37	0.04	Peripheral, neuraxial†	Nationwide center	Major LAST
Liu et al, 2016[48]	3	80,661	0.04	0.004	Peripheral	Single-center high-volume practice	Major LAST
Allegri et al, 2016[49]	10	29,545	0.34	0.03	Peripheral: 29,545 Neuraxial†: 4954	Multicenter	Minor LAST, 3; major LAST, 7
Morsiani et al,‡ 2017[50]	434	238,473	1.8	0.18	Peripheral	Administrative database	Surrogate markers for LAST

Total number of LAST events and denominator from clinical registries is 69 and 251,325, respectively, giving an incidence of LAST events of 0.03% or 0.27 (95% CI, 0.21–0.35) per 1000 PNBs. 59 (72%) of 69 LAST events were major (42 seizures, 8 CV events including 1 cardiac arrest), and 19 (28%) were minor LAST events.
*95% CI per 10,000 PNBs calculated by authors for zero events.
†Spinal anesthesia excluded from denominator.
‡Use of surrogate markers to identify LAST events, therefore not used in incidence calculations.
GA indicates general anaesthesia; n, number of events after PNBs; N, denominator of PNB.

Incidence:
1.8 per 1000 nerve blocks

Macfarlane AJR et al. Anaesthesia 2021
Gitman M et al. RAPM 2018.

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Clinical Setting of LAST is Changing

- Shifting **away** from anesthesia providers in an OR setting **to** non-anesthesia providers including in remote locations
- Between Dec 2017 and May 2020, **36 cases** of LAST published
  - 61% hospital
  - **17% outpatient surgery centers**
  - 14% outpatient clinics (e.g., dental, pain, urology)
  - Personnel administering the local anesthetic: 50% anesthesiologists; **39% surgeons/proceduralists**; 5.5% dentists, and 5.5% self-administered

Macfarlane AJR et al. Anaesthesia 2021

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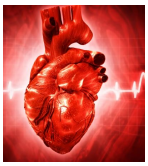
Mechanism of Action, LAST

Local anesthetic systemic toxicity causes sodium channel blockade

Neuro: disrupts inhibitory neuron depolarization → **excitatory** neurological features



CV: 1) disruption of normal conduction; 2) reduced contractility; 3) negative effect on systemic vascular tone

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Clinical Manifestation of LAST

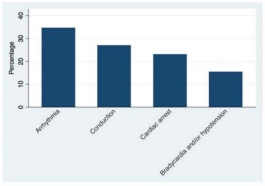

FIGURE 5. Bar graph showing the frequency of cardiovascular symptoms and signs. Arrhythmia (includes tachycardia, ventricular tachycardia or fibrillation); conduction disturbances (includes widened electrocardiogram or other changes [eg, ST segment changes]); cardiac arrest (includes pulseless electrical activity, asystole); as determined by authors of the case reports.

- **Early signs:** dizziness, drowsiness, tinnitus
- Sedation or general anesthesia ***may mask*** initial signs/increase seizure threshold so first sign may be CV collapse
- Neuro: seizure → coma
- Cardiac: excitatory → myocardial depressant

Gitman M et al. RAPM 2018

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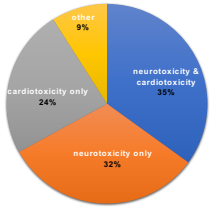
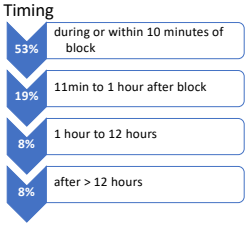
LAST may have variable presentation and speed of onset

Features



Timing



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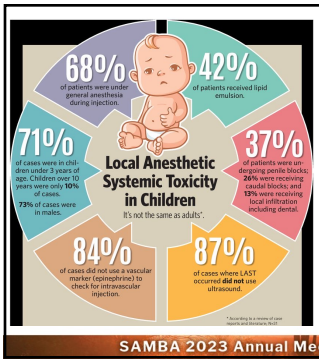

Review of 31 case reports in peds of LAST 2014-2019

Events occurred despite staying within maximum local anesthetic dosing guidelines

anesthesiologists mostly administered **below** recommended maximum

surgeons almost exclusively administered the **maximum**

dentists and **primary care physicians** were most likely to give larger than recommended **maximum**

Singaravelu RA, Boretsky K. RAPM 2021
Gupta RK, Schwenk ES. RAPM 2021

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Block type and risk of LAST

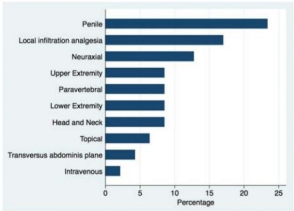

FIGURE 1. Bar graph showing the block types that caused LAST. Penile, penile block; upper extremity, includes variation of brachial plexus blockade; lower extremity, includes variations of sciatic and femoral nerve blocks.

Gitman M et al. RAPM 2018

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Risk factors LAST

- Drug dosage
- Extremes of age
- Low BMI (<17)
- Cardiac disease
- Pregnancy
- Renal disease
- Liver dysfunction

Suggested dosing recommendations for commonly used local anesthetic agents

Local anesthetic	Plain		With epinephrine	
	Maximum dose	Maximum dose	Maximum dose	Maximum dose
Bupivacaine	2 mg·kg^{-1}	175 mg	3 mg·kg^{-1}	225 mg
Levobupivacaine	2 mg·kg^{-1}	200 mg	3 mg·kg^{-1}	225 mg
Lidocaine	5 mg·kg^{-1}	350 mg	7 mg·kg^{-1}	500 mg
Mepivacaine	5 mg·kg^{-1}	350 mg	7 mg·kg^{-1}	500 mg
Ropivacaine	3 mg·kg^{-1}	200 mg	3 mg·kg^{-1}	250 mg
Prilocaine	6 mg·kg^{-1}	400 mg	8 mg·kg^{-1}	600 mg

Notes: Data from Berde and Strichartz[32] Dadure C, Sola C, Dalens B, Capdevila X. Regional anesthesia in children. In: Miller RD (Ed.). *Miller's Anesthesia*, eighth ed. Philadelphia: Elsevier; 2015:2718.[32] American Academy of Pediatrics; American Academy of Pediatric Dentistry; Cote CJ, Wilson S; Work Group on Sedation. Guidelines for monitoring and management of pediatric patients during and after sedation for diagnostic and therapeutic procedures: an update. *Pediatrics* 2006;118:2587–2602.[25]

El-Boghdadly K et al. Local Reg Anesth 2018

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Risk factors and mitigating measures to reduce risk of LAST

Table 1 Summary of the common risk-factors and mitigating measures to reduce the risk of local anaesthetic systemic toxicity. Note that when combinations of patient comorbidities and/or other risk-factors make local anaesthetic systemic toxicity (LAST) a sufficiently high risk for a given patient, it is reasonable to seek alternatives to peripheral nerve, fascial plane, field and other blocks that require relatively high doses of local anaesthesia.

Risk-factors	Mitigating factors
Local anaesthetic and method	
	Choose least cardiotoxic local anaesthetic (e.g. lidocaine) or method with lowest local anaesthetic dose required (e.g. spinal) where possible
Block factors	
Dosing	Recognise maximum limits are only a guide and consider pharmacokinetic and pharmacodynamic variables in individual patients Use lowest dose possible to maximise success (ED_{95}) while ensuring adequate duration of anaesthesia/analgesia Extra care is needed with repeat dosing/catheters in at risk groups (children and low local anaesthetic clearance in particular)
Site of injection	Consider adrenaline to limit local anaesthetic bioavailability where risk of systemic absorption is high
Block conduct	Ultrasound guidance significantly reduces risk Incremental injection Aspiration before injection Consider using adrenaline as a marker of intravascular injection Use NRI-it™ technology Blocks in awake patients theoretically allows earlier detection; avoid over-sedating the patient while placing a block

Macfarlane AJR et al. Anaesthesia 2021

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Risk factors and mitigating measures to reduce risk of LAST, continued

Patient factors	
Age	Reduce dose in infants Reduce dose in elderly by 10–20%
Pregnancy	Use minimum effective dose
Hepatic disease	Reduce dose in continuous infusions
Renal disease	Consider reducing dose in end stage renal failure or chronic renal insufficiency where uraemic and/or acidotic
Cardiac disease	Recognise increased risk of LAST Consider reduced dose in severe ventricular dysfunction or even consider avoiding nerve block altogether
Miscellaneous	Recognise increased risk in malnourishment/hypoproteinemia; sarcopenia diabetes; mitochondrial metabolic disease; and carnitine deficiency Consider reduced dose
Non-technical factors	
	Knowledge and education of all staff where local anaesthetic is administered At-risk patient groups Signs and symptoms of LAST to facilitate prompt recognition Treatment guidelines Consider stocking a 'local anaesthetic toxicity box' Communication – be vigilant where other providers may also administer local anaesthetic in the peri-operative period (e.g. surgeon; intravenous lidocaine) to avoid excessive total dose Consider including local anaesthetic dosing in the surgical pause and sign-out

Macfarlane AJR et al. Anaesthesia 2021

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Clinical management of LAST

- **Checklist** for treatment of LAST
  - ASRA
    - 2008 practice advisory
    - 2010 ASRA LAST Checklist
    - 2020 revised checklist
- **LAST resuscitation differs from ACLS resuscitation**
  - Standard ACLS drugs can worsen LAST outcomes
- Lipid emulsion: like dantrolene, "a crucial **antidote**" but not a panacea

Macfarlane AJR et al. Anaesthesia 2021

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2010 ASRA checklist

American Society of Regional Anesthesia and Pain Medicine

Checklist for Treatment of Local Anesthetic Systemic Toxicity

The Pharmacologic Treatment of Local Anesthetic Systemic Toxicity (LAST) is Different from Other Cardiac Arrest Scenarios

- ☐ Get Help
- ☐ Initial Focus
  - ☐ Airway management: ventilate with 100% oxygen
  - ☐ Seizure suppression: benzodiazepines are preferred; AVOID propofol in patients having signs of cardiovascular instability
  - ☐ Alert the nearest facility having cardiopulmonary bypass capability
- ☐ Management of Cardiac Arrhythmias
  - ☐ Basic and Advanced Cardiac Life Support (ACLS) will require adjustment of medications and perhaps prolonged effort
  - ☐ AVOID vasopressin, calcium-channel blockers, beta blockers, or local anesthetic
  - ☐ REDUCE individual epinephrine doses to ≤1 mcg/kg
- ☐ Lipid Emulsion (20%) Therapy (values in parenthesis are for 70kg patient)
  - ☐ Bolus 1.5 mL/kg (lean body mass) intravenously over 1 minute (~100mL)
  - ☐ Continuous infusion 0.25 mL/kg/min (~18 mL/min; adjust by roller clamp)
  - ☐ Repeat bolus once or twice for persistent cardiovascular collapse
  - ☐ Double the infusion rate to 0.5 mL/kg/min if blood pressure remains low
  - ☐ Continue infusion for at least 10 minutes after attaining circulatory stability
  - ☐ Recommended upper limit: Approximately 10 mL/kg lipid emulsion over the first 30 minutes
- ☐ Post LAST events at www.lipidrescue.org and report use of lipid to www.lipidregistry.org

Figure 1. Used with permission of ASRA.

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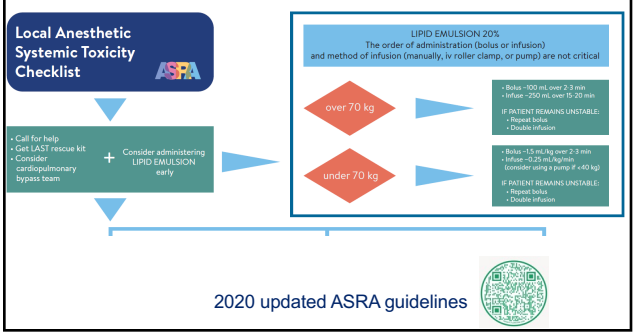

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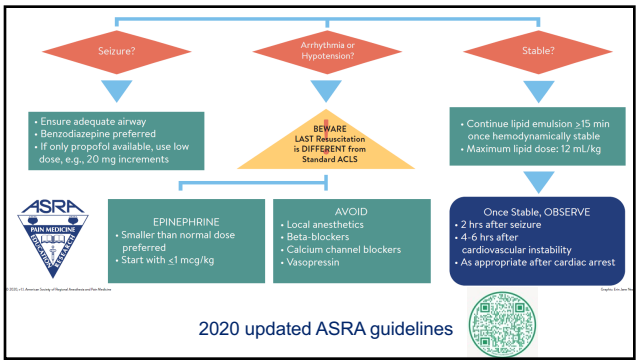

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Current areas of interest in LAST research

- Fascial plane blocks
- Liposomal bupivacaine
- Catheters
- Local infiltration analgesia in total joint arthroplasty
- Tumescent anesthesia

El-Boghdadly K et al. Local Reg Anesth 2018

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Key Points for the Ambulatory Setting

- Despite low incidence of LAST in current practice, even a single episode of LAST can lead to **serious harm/death** if not treated promptly and appropriately
- Clinical setting of LAST is **changing**, reports of LAST in ASCs and non-anesthesiologists administering local anesthesia
- **Constant** vigilance, preventive safety steps, raising awareness and educating (including our non-anesthesia colleagues) are necessary
- **Stock intralipid** if local anesthesia is used in nerve blocks or surgeon infiltration
  - It's cheap and has a long shelf life
- **Simulation** with multidisciplinary team
- http://lipidrescue.org/ is a great **online resource**

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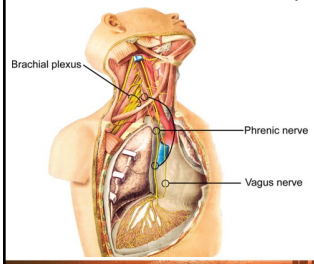
Block specific complications: Interscalene block and phrenic nerve palsy



Phrenic nerve palsy

- *Transient*: 100% with 20mL local anesthesia
- *Persistent*: 1/2000 or 1/100; may be multifactorial (cervical spinal stenosis + nerve trauma + local anesthetic)

El-Boghdadly K et al. Anesthesiology 2017

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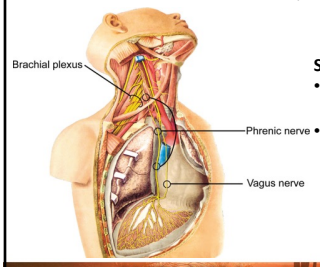
Block specific complications: Interscalene block and phrenic nerve palsy



Strategies to reduce phrenic nerve palsy

- Reduce dose (volume/concentration)
  - 10mL ↓ incidence of palsy to 60%
- Modify injection site: superior trunk block

El-Boghdadly K et al. Anesthesiology 2017
Kim DH et al. Anesthesiology 2019

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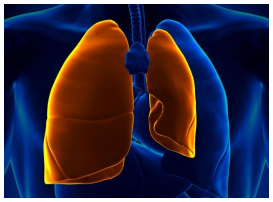
Block-specific complications: paravertebral block and pneumothorax



- Lonnqvist 1995: 367 pts; **PTX 0.5%**
- Naja 2001: 642pts; **PTX 0.5%**
- Pace 2016: 856 pts; **PTX 0%**
- Kelly 2018: 1152 pts; **PTX 0.26%**

- Our experience: 2251 pts; **PTX 0.04%**

Lönnqvist PA et al. Anaesthesia 1995
Naja Z and Lönnqvist PA. Anaesthesia. 2001
Pace MM et al. Anesth Analg. 2016
Kelly M, et al. Breast J. 2018

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Ann Surg Oncol (2022) 29:4777–4786
https://doi.org/10.1245/s10434-022-11724-9

Annals of
SURGICAL ONCOLOGY
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REVIEW ARTICLE – BREAST ONCOLOGY

The Use of Pectoralis Blocks in Breast Surgery: A Practice Advisory and Narrative Review from the Society for Ambulatory Anesthesia (SAMBA)

Alberto E. Ardon, MD, MPH[1], John E. George III, MD[2], Kapil Gupta, MD[3], Michael J. O'Rourke, MD[4], Melinda S. Seering, MD[5], Hanae K. Tokita, MD[6], Sylvia H. Wilson, MD[7], Tracy-Ann Moo, MD[6], Ingrid Lizarraga, MBBS[5], Sarah McLaughlin, MD[1], and Roy A. Greengrass, MD[1]

For patients undergoing a mastectomy, a PECS block may provide an opioid-sparing effect similar to that achieved with PVB; SAMBA recommends the use of a PECS block if a patient is unable to receive a PVB (Strength of Recommendation A).

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Thank you

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