The Ideal Local Anesthetic

- Water soluble/stable in solution
- Non-irritating to nerve
- Low systemic toxicity
- Short induction period
- Adequate duration of action
- No post anesthetic side effects
- Vasoconstriction effect

Percent Solution

- Different anesthetics come in various concentrations
- These concentrations are given as a percentage
  - .5% = 5 mg/cc
  - 1% = 10 mg/cc
  - 2% = 20 mg/cc
- Multiply by 1.8cc to determine how many mg are in a dental cartridge

Contents of a dental cartridge

- Anesthetic agent *e.g.*, lidocaine, mepivacaine etc
  - Anesthesia, vasodilatation
- Vasoconstrictor: epinephrine or levonordefrin
  - Decreases absorption of anesthetic agent into blood, thereby increasing the duration of action and decreasing its toxicity
- Sodium metabisulfite
  - Vasoconstrictor preservative
- Isotonic sodium chloride

Contents cont:

- In multi-dose vials
  - Methylparaben may be present
    - Preservative for the anesthetic agent
    - Moderate incidence of allergic reaction
  - Not present in single-dose dental cartridges
Concentration of vasoconstrictor

<table>
<thead>
<tr>
<th>Concentration</th>
<th>Milligrams per milliliter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1000</td>
<td>1.0</td>
</tr>
<tr>
<td>1:2500</td>
<td>0.4</td>
</tr>
<tr>
<td>1:10,000</td>
<td>0.1</td>
</tr>
<tr>
<td>1:20,000</td>
<td>0.05</td>
</tr>
<tr>
<td>1:50,000</td>
<td>0.033</td>
</tr>
<tr>
<td>1:100,000</td>
<td>0.02</td>
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<tr>
<td>1:200,000</td>
<td>0.01</td>
</tr>
<tr>
<td>1:500,000</td>
<td>0.005</td>
</tr>
</tbody>
</table>

More common concentrations of vasoconstrictors in dental cartridges include:
1:50,000
1:100,000
1:200,000

Chemical Configuration of Local Anesthetic Compounds in Dentistry

- Amides
- Esters

Locals are Comprised of:

- An aromatic lipophilic group
- Ester or amide linkage
- A hydrophilic secondary or tertiary amino group, which forms water soluble salts when combined with acids

Amides vs Esters

- Major difference is method of metabolism
  - Amides: majority of the drug is metabolized in the liver
    - Use with caution in patients with severe liver disease
    - Use lower dose to avoid toxicity
  - Esters are metabolized in the plasma by pseudocholinesterase
    - PABA is a major metabolite of ester metabolism
      - Known allergen
    - Atypical pseudocholinesterase deficiency
      - Patients will not be able to metabolize; toxicity may ensue
Amide Local Anesthetics
- Articaine
- Bupivicaine
- Etidocaine
- Lidocaine
- Mepivacaine
- Prilocaine

Ester Local Anesthetics
- Butacaine
- Cocaine
- Hexylcaine
- Piperocaine
- Tetracaine
- Benzocaine
- Chlorprocaine
- Procaine
- Propoxycaine

Pharmacology and Physiology

Nerve Conduction
- Resting membrane potential -60 to -90
- Stimulus
- Slow depolarization
- Threshold reached causing action potential
- Repolarization

Nerve conduction

At resting potential
- Axoplasm is negative (around -70mV)
- Membrane is freely permeable to K+ and Cl-
- Membrane is only slightly permeable to Na+

Nerve excitation causes
- Increase in the permeability of the membrane to Na+
- The rapid influx of Na+ to the interior of the nerve cell causes the axoplasm to become more positive
- The firing threshold is reached (-50 to -60mV)
- An action potential is created
Nerve conduction

Repolarization
- At the end of the action potential, the electric potential is positive (+40mV)
- The nerve membrane becomes impermeable to Na+
- There is an efflux of K+ and there is a return to normal resting potential

Mechanism of Action of Local Anesthetic Agents

There are different unproven theories to explain the exact mechanism of action of local anesthetics

The basic fact is that sodium channels are blocked preventing sodium ions from crossing the membrane

This causes blockage of the formation of an action potential

Mechanism of Action of Local Anesthetic Agents

- Depression of rate of electrical depolarization
- Failure to achieve threshold potential level
- Lack of development of AP
- Conduction blockade

Clinical characteristics of Local Anesthetics

- Onset
- Duration of action
- Dosing

Henderson hasselbach equation

- Determines how much of a local anesthetic will be in a non-ionized vs ionized form
- Based on tissue pH and anesthetic Pk_a

Henderson Hasselbach cont

- Injectable local anesthetics are weak bases (pK_a=7.5-9.5)
- When a local anesthetic is injected into tissue it is neutralized and part of the ionized form is converted to non-ionized
- The non-ionized base is what diffuses into the nerve
- The ionized form is responsible for action
**Henderson Hasselbach cont**

- If the tissue is infected, the pH is lower (more acidic) and according to the HH equation; there will be less of the non-ionized form of the drug to cross into the nerve (rendering the LA less effective).
- Once some of the drug does cross; the pH in the nerve will be normal and therefore the LA re-equilibrates to both the ionized and nonionized forms; but there are fewer cations which may cause incomplete anesthesia.

**Factors affecting LA action**

- Lower pKa = more rapid onset (more LA in non-ionized form to diffuse through)
- Increased lipid solubility = increased potency
- Increased protein binding = longer duration of action

**Maximum Recommended Doses of Local Anesthetics**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Formulation</th>
<th>M.R.D.</th>
<th>mg/kg</th>
<th>Author's M.R.D.</th>
<th>mg/kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bupivacaine</td>
<td>Plain</td>
<td>1-2</td>
<td>0.5</td>
<td>1.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Lidocaine</td>
<td>Plain</td>
<td>2.0</td>
<td>1.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Mepivacaine</td>
<td>Plain</td>
<td>2.0</td>
<td>1.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>Plain</td>
<td>2.0</td>
<td>1.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Propracaine</td>
<td>Plain</td>
<td>2.0</td>
<td>1.5</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Prilocaine</td>
<td>w/ epinephrine</td>
<td>3.0</td>
<td>2.0</td>
<td>3.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Lidoacaine</td>
<td>w/ epinephrine</td>
<td>3.0</td>
<td>2.0</td>
<td>3.5</td>
<td>2.0</td>
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<td>3.0</td>
<td>2.0</td>
<td>3.5</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Manufacturers' recommendation: does not exceed recommended dosage.*
Lidocaine HCL (Xylocaine)

- 2% concentration
  - Pulpal anesthesia 5 minutes
- Onset of action is 2-4 minutes
- Vasoconstrictor concentration
  - 1:100,000 epinephrine
  - 1:50,000 epinephrine
  - Pulpal anesthesia for 60-90 minutes

Mepivacaine HCL (Polocaine, Carbocaine)

- 3% concentration without vasoconstrictor
  - Sulfite free
  - Onset of action 30 sec - 4 min
  - Operating anesthesia time of 20-40 minutes
- 2% concentration with 1:20,000 levonordefrin
  - Operating anesthesia time of 1-5.5 hours

Long Acting Local Anesthesia

- 0.5% bupivicaine with 1:200,000 Epi
  - Marcaine
  - Max dose 1.3mg/kg; total max 90mg
  - Duration of action pulpal: 90-180 min, soft tissue: up to 12 hrs

Vasoconstrictors
### Naturally Occurring Vasoconstrictors
- Epinephrine
- Norepinephrine

### Adrenergic Agents
- **Alpha**: vasoconstriction
- **Beta 1**: cardiac smooth muscle
  - + chronotrope
  - + ionotrope
- **Beta 2**: bronchiolar smooth muscle
  - bronchodilation

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### Clinical Effects of Vasodilation
- Increase rate of absorption
  - Decreases duration of pain control
  - Increases anesthetic blood level
  - Increases potential for overdose

### Vasoconstrictors should be included unless contraindicated

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### Mode of Action
- Attach to and directly stimulate adrenergic receptors
- Act indirectly by provoking the release of endogenous catecholamine from intraneuronal storage sites
- Combination of 1 and 2

### Epinephrine (Adrenalin)
- Most potent vasoconstrictor used in dentistry
- Concentrations of 1:50,000 to 1:200,000 in dental cartridges
Concentrations of Vasoconstrictor in Local Anesthetics

<table>
<thead>
<tr>
<th>Concentration</th>
<th>mg/ml</th>
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<tbody>
<tr>
<td>1:50,000</td>
<td>0.020</td>
</tr>
<tr>
<td>1:100,000</td>
<td>0.010</td>
</tr>
<tr>
<td>1:200,000</td>
<td>0.005</td>
</tr>
</tbody>
</table>

Calculation:
1:50,000 =
1 gram/50,000 ml =
1000 mg/50,000 ml =
1 mg/50 ml = 0.02 mg/ml

Levonordefrin (Neo - Cobefrin)
- One fifth as active as epinephrine
- Acts on alpha sites

Vasoconstrictors - Unstable in Solution
Sodium metabisulfite added
Known allergen

Metabolism of Adrenergic Agonists
- Re-uptake
- Inactivation by catechol-o-methyltransferase COMT
- Monoamine oxidase MAO

Max dose of vasoconstrictors
- Healthy patient approximately 0.2 mg
- Patient with significant cardiovascular history: 0.04 mg

- How many carpules of 2% lidocaine with 1:100,000 epi is max dose for CV patient?
### Max Dose for Vasoconstrictors (CV patient)

- 1 carpule = 1.8cc
- 1:100,000 = 0.01mg/cc
- 0.01 X 1.8cc = 0.018mg
- 0.04/0.018 = 2.22 carpules

### In a healthy adult patient

- 0.2/0.018 = 11.1 carpules

### Toxic Reactions and Side Effects

- **Systemic toxicity**
  - Inadvertent intravascular injection
  - Administration of large quantities
  - Altered drug metabolism
- **Local tissue responses**
- **Idiosyncratic reactions**
- **Allergic reactions**

### Allergens in Local Anesthesia

- **The agent itself**
- **PABA**
- **Sodium metabisulfite**
- **Methyl paraben**

### Systemic Toxicity of Local Anesthesia

- **Convulsions**
  - Usually self-limiting
  - Can be treated with:
    - Diazepam
    - Barbiturate
    - Succinylcholine
- **Respiratory depression**
- **Cardiovascular collapse**

- **Principle 1** - No drug ever exerts a single action
- **Principle 2** - No clinically useful drug is entirely devoid of toxicity
- **Principle 3** - The potential toxicity of a drug rests in the hands of the user
Pain and Anxiety
Armamentarium
Local Anesthesia Administration Techniques

Oral and Maxillofacial Surgery
University of Minnesota

Armamentarium

• 1.) The Syringe
• 2.) The Needle
• 3.) The Cartridge

Types of Syringes

1) Non-disposable syringes
   a. Breech-loading, metallic, cartridge-type, aspirating
   b. Breech-loading, plastic, cartridge-type, aspirating
   c. Breech-loading, plastic, cartridge-type, self-aspirating
   d. Pressure syringe for periodontal ligament injection
2) Disposable syringe
3) Safety syringe
4) Computer controlled local anesthetic delivery systems

Syringe Components

• 1.) Needle adapter
• 2.) Piston with harpoon
• 3.) Syringe barrel
• 4.) Finger grip
• 5.) Thumb ring

Pressure syringe
The Needle

• Gauge: the larger the gauge the smaller the internal diameter of the needle
  - 25g red cap
  - 27g yellow cap
  - 30g blue cap

Long Needle: 32mm
Short Needle: 20mm

Differences by manufacturer

Components of the needle

• 1.) Bevel
• 2.) Shank (shaft)
• 3.) Hub
• 4.) Syringe adapter
• 5.) Syringe penetrating end
The Cartridge

Cartridge (carpule)
-1.8 mL (United States)
-2.2 mL (UK and Australia)
-should not be autoclaved
-stored at room temperature (21°C to 22°C (70°F to 72°F))
-should not soak in alcohol
-should not be exposed to direct sunlight

Preparation of the Armamentarium
• 1.) remove syringe from sterile bag
• 2.) attach needle
• 3.) retract piston fully
• 4.) insert cartridge
• 5.) engage the harpoon
• 6.) carefully remove colored cap
Recapping the Needle

- Always use the scoop technique
- This is the time you are most likely to get stuck by the needle
Bent needles

- Bending needles weakens them
- Increases risk of needle breakage

Remove the cartridge from the syringe

- Withdraw the harpoon fully
- Place the cartridge in the sharps container

Removal of the Needle

- Remove the needle by twisting it off the needle adaptor – Leave the needle adaptor on the syringe!
- Place the needle in the sharps container
Other Armamentarium

1) Topical Anesthetic (strongly recommended)
   - ointments, gels, pastes, sprays
   - sprays: unmetered, metered
2) Applicator sticks
3) Cotton gauze (2” x 2”)
4) Hemostat
DentiPatch (lidocaine transoral delivery system)

- Preinjection
  - 10-15 minutes exposure prior to injection
- Root scaling/planing
  - apply 5-10 minutes prior to beginning procedure

Injection Technique

Steps for Injection

1. Use sterilized sharp needle
2. Check the flow of local anesthetic solution
3. Position the patient
4. Dry the tissue
5. Apply topical anesthetic

Steps for Injection (cont)

6. Communicate with the patient (pain, discomfort)
7. Establish a firm hand rest
8. Make the tissue taut (stretching)
9. Keep the syringe out of the patient's line of sight
10. Insert the needle into the mucosa level
Steps for Injection (cont)
Slowly advance the needle toward the target (few drops while advancing needle)
Aspirate (negative pressure, self aspirating syringe)
Slowly deposit the local anesthetic solution (1 mL/min, 1.8 mL/min practical)
Slowly withdraw the syringe (recapping, scoop technique)
Observe the patient

Maxillary Injection Technique
• Supraperiosteal (Infiltration)
• Posterior Superior Alveolar (PSA)
• Middle Superior Alveolar (MSA)
• Anterior Superior Alveolar (Infra-orbital)
• Maxillary (V₂ division) N. Block
• Greater Palatine N. Block
• Nasopalatine N. Block

Supraperiosteal Injection (Infiltration)
• Bevel: toward bone
• 0.6mL
• Syringe: parallel with long axis of the tooth
• Mucobuccal fold

Anatomical Landmarks
• Individual teeth
• Root areas
• Periosteum of the bone