Review of Local Anesthetics With a Discussion of Prilocaine 4%

A Peer-Reviewed Publication
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Educational Objectives
Upon completion of this course, the clinician will be able to do the following:
1. List and describe available local anesthetics and their chemical components
2. Review the considerations involved in selecting a local anesthetic
3. List the recommended doses of local anesthesia for adults and children
4. List and describe complications that can arise from use of local anesthesia

Abstract
Many studies show that prilocaine is as effective as any amide local anesthetic in the marketplace for adults and children. The choice of which local anesthetic to use might be decided upon by considering the duration of pulpal anesthesia required. Prilocaine can produce maximum pulpal anesthesia with minimal vasoconstrictor use, or it can provide short duration pulpal anesthesia with no vasoconstrictor use. As well, there are advantages to limiting or even completely eliminating vasoconstrictor from the local anesthetic solution. The patient’s medical history, acidification of tissues and pulpal insult are some of the factors to consider. Prilocaine is an effective drug to add to your local anesthesia armamentarium.

Introduction
When it comes to the use of local anesthetics, there are a variety of choices available to the practitioner. Historically, this was not the case. The first local anesthetic used in medicine was cocaine. This occurred in 1884 when Dr. Karl Koller used it for ophthalmic surgery. In that same year, Dr. William Halstead, a dentist from Baltimore mixed cocaine with boiling water and injected it in an effort to block the hemimandible. Due to the addictive and inebriating nature of cocaine use, the need to find a product that had the anesthetizing capabilities of cocaine without the other physical side effects became apparent. Thus in 1900, Alfred Einhorn was able to describe the molecular structure of cocaine. This in 1905 led to the synthesis of procaine (Novacaine) by Braun. Both cocaine and procaine are ester local anesthetics, which although wonder drugs in the early 1900’s, have some undesirable properties. These include long onset of action, short duration of action and relatively high allergenicity. To counter these disadvantages, Löfgren discovered lidocaine in 1943 and thus, the first amide local anesthetic became available with vastly improved properties over the ester products.

Today, there are a variety of amide injectable local anesthetics available. Factors that influence the choice of anesthetic may include whether or not a vasoconstrictor is desired, the anesthetic concentration, and the specific properties desired. Specific clinical factors such as bony and neuroanatomy, vascularity, pH, duration of anesthesia required, and the patient’s medical history, might also influence the choice of anesthetic. This paper will focus on the local anesthetic prilocaine. The pharmacology, advantages, disadvantages and other characteristics of this drug will be explored.

Availability
Local anesthetics for dentistry are classified as either amides or esters. Today, all injectable local anesthetics for dental use are amides, including prilocaine. It should be noted however that prilocaine can also be used as a topical anesthetic. Prilocaine was first prepared by Löfgren and Tegner in 1953 and was introduced into the United States dental marketplace in 1971. Today, this drug remains one of the main choices utilized by dental practitioners. A study conducted in Ontario, Canada in 1995 surveyed dentists asking which type of local anesthetic they utilized. This study showed that prilocaine accounted for approximately 20% of all dental injections in Ontario (Figure 1). The chemical structure of prilocaine can be seen in Figure 2. This drug is chemically designated as propanamide, \((\text{N-}(2\text{-methyl-phenyl})\cdot 2\cdot(\text{propylamino})\cdot, \text{monohydrochloride)}\).

Figure 1. Local Anesthetic Use in Ontario, 1995

![Local Anesthetic Use in Ontario, 1995](image)

Figure 2. Chemical Structure of Prilocaine

Prilocaine is a white, odourless crystalline powder that is soluble in water and alcohol. In the United States, prilocaine is marketed as a 4% solution. It can be obtained as either a solution without a vasoconstrictor (Citanest® Plain DENTAL) or with a vasoconstrictor (Citanest® Forte DENTAL [with epinephrine 1:200,000]). The concentration of the vasoconstrictor is 1:200,000. Therefore in one cartridge, there is 0.009 mg of epinephrine.
One cartridge of Citanest DENTAL contains 1.8 ml of solution. Citanest Forte DENTAL contains these additional ingredients: 0.009 mg of epinephrine (1:200,000), sodium metabisulfite (an antioxidant for the vasoconstrictor) at 0.5 mg/ml, and citric acid (0.2 mg/ml). The pH of this solution is 3.3–5.5. Figure 3 shows the contents of these cartridges.

Figure 3. Cartridge Contents

<table>
<thead>
<tr>
<th>Purpose</th>
<th>no epi</th>
<th>with epi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prilocaine</td>
<td>40mg/ml</td>
<td>40mg/ml</td>
</tr>
<tr>
<td>Epi bitartrate</td>
<td>0.005 mg/ml</td>
<td>0.005 mg/ml</td>
</tr>
<tr>
<td>Citric acid</td>
<td>0.2mg/ml</td>
<td>0.2mg/ml</td>
</tr>
<tr>
<td>Sodium Metabisulphite</td>
<td>0.5mg/ml</td>
<td>0.5mg/ml</td>
</tr>
<tr>
<td>Sodium hydroxide and/or Hydrochloric acid</td>
<td>pH 6.0–7.0</td>
<td>pH 6.0–7.0</td>
</tr>
<tr>
<td>Water for injection</td>
<td>Volume To 1.8 ml</td>
<td>To 1.8 ml</td>
</tr>
</tbody>
</table>

Pharmacology
Prilocaine is moderately lipophilic, similar to lidocaine but less lipophilic than bupivacaine. The lipophilic nature of a local anesthetic is important so that it is able to diffuse through the lipid membrane layer of the nerve sheath.

The product monographs list the following characteristics: The onset of action for infiltration anesthesia in the maxilla with Citanest Forte DENTAL (with epinephrine) is approximately 2 minutes with a duration for soft tissue anesthesia lasting around 2 hours and pulpal anesthesia approximately 45 minutes. Donaldson et al. tested the onset time of pulpal anesthesia following maxillary infiltrations with Citanest with epinephrine in adults. They reported an onset time of 97.5 seconds, close to the product monograph. Citanest Plain DENTAL (no vasoconstrictor) has a 2–3 minute onset of action for maxillary infiltrations, with soft tissue anesthesia lasting approximately 1–1.5 hours and pulpal anesthesia lasting approximately 15 minutes (Figure 4).

For inferior alveolar nerve blocks, Citanest Forte DENTAL (with epinephrine) has an approximate onset of 2–4 minutes and an average duration for soft tissue anesthesia of around 3 hours and pulpal anesthesia for approximately 1.5 hours. In Donaldson’s study, when used for inferior alveolar nerve blocks this local anesthetic had an onset time of 131.25 seconds, again close to the product monograph. Citanest Plain DENTAL (no epinephrine) has an onset of action of greater than 5 minutes for inferior alveolar nerve blocks with duration of soft tissue anesthesia lasting 2.5 hours. The duration of pulpal anesthesia is 1–1.5 hours (Figure 5).

Amide local anesthetics are metabolized in the liver. Prilocaine is an exception as it is metabolized primarily in the liver and excretions following an intravenous injection, serum concentrations decrease more quickly than with lidocaine. The main mechanism for breakdown of the prilocaine molecule is hydrolysis of the amide bond. This results in the by-product o-toluidine (which can induce methemoglobinemia discussed below) and n-propylalanine. O-toluidine is broken down into 4-hydroxy-o-toluidine and 6-hydroxy-o-toluidine (Figure 6).

Dosages
As with any local anesthetic, the lowest effective dose should always be utilized. As well, when maximum doses are printed, they relate to the average, healthy 70 kg (154 lb) adult. There are three aspects to consider here. First even if the patient is heavier than 70 kg (154 lb) the maximum dose allowable must be adhered to. Second, there

Table 1: Onset and Duration of Anesthesia

<table>
<thead>
<tr>
<th>Anesthesia Type</th>
<th>Onset Time (min)</th>
<th>Duration Pulpal Anesthesia (min)</th>
<th>Duration Soft Tissue Anesthesia (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Citanest no epi</td>
<td>2–3</td>
<td>15</td>
<td>60–90</td>
</tr>
<tr>
<td>Citanest with epi</td>
<td>2</td>
<td>45</td>
<td>120</td>
</tr>
<tr>
<td>Citanest no epi</td>
<td>&gt;5</td>
<td>60–90</td>
<td>150</td>
</tr>
<tr>
<td>Citanest with epi</td>
<td>2–4</td>
<td>90</td>
<td>180</td>
</tr>
</tbody>
</table>

Figure 4. Onset and Duration of Anesthesia for Maxillary Infiltrations

Figure 5. Onset and Duration of Anesthesia for Inferior Alveolar Nerve Blocks

Figure 6. The Breakdown Products of Prilocaine

o-toluidine
4-hydroxy o-toluidine
6-hydroxy o-toluidine
n-propylalanine
are people who are more sensitive to the effects of any drug, including local anesthetics. These people may not be able to tolerate higher doses without exhibiting signs and symptoms of toxicity. Finally, the maximum values are suggested for healthy individuals. Patients with compromised liver and or cardiac function may not be able to tolerate normal doses of any local anesthetic.

Prilocaine is one of the least toxic amide local anesthetics. A healthy adult maximum dose, as recommended by the manufacture, is 6 mg/kg. Some sources have suggested a maximum dose for healthy adults as 8 mg/kg with a maximum amount for one appointment being 500 mg. When one considers that the maximum amount for one visit is 500 mg for the healthy adult, the discrepancy between 6 vs. 8 mg/kg becomes less important for adults. However this author recommends staying within the 6 mg/kg dose range, with the 500 mg maximum allowed for larger individuals, as this will allow for a wider margin of safety for lighter adults and those who have a lower tolerance for the toxic effects of local anesthetics. It will also help to avoid methemoglobinemia in susceptible individuals. For children, the American Academy of Pediatric Dentistry suggests that no more than 4 mg/kg of any amide local anesthetic should be given to children patients. To translate these values into numbers of cartridges, see Figures 7 and 8. Figure 8 illustrates that for a child weighing 44 lbs (approximately 20 kg), only 1.11 cartridges of prilocaine can be injected before reaching the 4 mg/kg maximum. This highlights the disadvantage of using 4% solutions on small children. Doses add up very quickly and because of this, 2% lidocaine may be the safest drug in small children, especially when more than one cartridge is required. For this same 44 lb child, the practitioner could use 2.22 cartridges of lidocaine before reaching the 4 mg/kg threshold toxic levels with this 2% solution.

As well, it is thought that local anesthetics with vasoconstrictor allow for the widest margin of safety since the vasoconstrictor will decrease the local anesthetic’s ability to enter the vasculature. This is an interesting point with prilocaine since most references do not differ in the suggested maximum recommended doses for prilocaine with a vasoconstrictor as compared to prilocaine without a vasoconstrictor. One possible reason for this is that prilocaine is not a potent vasodilator. This allows prilocaine to be available as a plain solution and still have some effectiveness. Lidocaine and articaine are more potent vasodilators and as such, must be used with a vasoconstrictor to prevent quick uptake by the vasculature.

**Indications**

Prilocaine is an effective local anesthetic and is indicated for most if not all dental procedures. There are of course specific indications where this drug can be used most advantageously and there are situations when this drug may not be the formulation of choice.

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**Figure 7.** Calculation of the amount of Prilocaine in one cartridge

<table>
<thead>
<tr>
<th>Drug</th>
<th>Amount/ml</th>
<th>Number of Cartridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>4% prilocaine</td>
<td>40</td>
<td>1.8</td>
</tr>
<tr>
<td>one cartridge</td>
<td>1.8 ml</td>
<td>72 mg prilocaine</td>
</tr>
</tbody>
</table>

**Figure 8.** Maximum allowable doses for children and adults translated into number of cartridges allowed

<table>
<thead>
<tr>
<th>Age Range</th>
<th>Dose Range</th>
<th>Maximum total dose</th>
<th>Number of Cartridges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child (20 kg or 44 lbs)</td>
<td>4 mg/kg</td>
<td>80 mg</td>
<td>1.11</td>
</tr>
<tr>
<td>Adult (70 kg)</td>
<td>6 mg/kg</td>
<td>500 mg</td>
<td>6.9</td>
</tr>
</tbody>
</table>

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Citanest Forte DENTAL with epinephrine is considered an intermediate acting anesthetic and as such can be used for any dental procedure. Citanest Plain DENTAL without vasoconstrictor has a short duration of pulpal anesthesia when given via infiltration (15 minutes) and therefore should only be used for procedures where pulpal insult can be completed before anesthesia degradation occurs. For block anesthesia in the mandible, there are only slight differences between Citanest DENTAL with and without a vasoconstrictor. The interesting message here is that a practitioner can achieve an inferior alveolar nerve block of significant duration (1–1.5 hours) without the need to use epinephrine. This could be extremely advantageous for those patients who require minimal amounts of vasoconstrictor. Patients with high blood pressure, by-pass surgery, prior myocardial infarction, angina, uncontrolled diabetes, uncontrolled thyroid disorders and those taking non-cardioselective beta blockers, tricyclic antidepressants and cocaine are examples of patients who would benefit from the use of a solution without a vasoconstrictor. It must be stressed however that profound pulpal anesthesia is paramount, especially in those with cardiovascular concerns since the creation of pain during procedures will result in the patient releasing large amounts of endogenous epinephrine. This could result in a medical emergency. The practitioner must be cognisant of the durations of action in both the maxilla and mandible when using solutions without vasoconstrictor.

Citanest Forte DENTAL with epinephrine has the advantage of containing the minimal amount of vasoconstrictor at 1:200,000 (half the amount of 1:100,000). If a practitioner utilizes less epinephrine at the site of surgery the result will be more bleeding. However when one considers both the profoundness of anesthesia and duration of anesthesia, there is no advantage in having epinephrine at a concentration greater than 1:200,000. Another interesting indication for using a plain solution is to minimize the discomfort created during the injection process. In one study, patients reported injection pain from either prilocaine without vasoconstrictor, mepivacaine with levonordefrin or lidocaine with epinephrine. The results indicated that patients perceived significantly less pain following injection with prilocaine as compared to mepivacaine or lidocaine. There was no difference between mepivacaine and lidocaine. In a second study, prilocaine plain was compared
to bupivacaine, which contains 1:200,000 epinephrine. It was shown that the injection of prilocaine plain elicited significantly less perceived pain than did bupivacaine. These results were consistent for injections in the palate, for inferior alveolar nerve blocks and for posterior maxillary buccal infiltrations. The most likely reason for these experimental results revolve around the pH of the solutions. Prilocaine plain has a pH of 6.0–7.0, bupivacaine with 1:200,000 epinephrine has a pH of 3.3–5.5, lidocaine with 1:100,000 epinephrine has a pH of around 4.5 and mepivacaine with 1:20,000 levonoredefrin has a pH of approximately 3. These studies suggest that the more acidic the solution is, the more discomfort will occur upon injection. Some practitioners have reported the technique of injecting prilocaine plain first to elicit as little discomfort as possible and then soon after, injecting an acidic vasoconstrictor-containing solution which now cannot create discomfort due to the anesthetized state of the tissue.

There are three final reasons to consider the advantage of using plain solutions or even solutions with minimal vasoconstrictor-concentration (i.e. 1:200,000). Firstly, using epinephrine for infiltrations can decrease the flow of blood to the pulp. This theoretically can increase the chance for pulpitis, especially following traumatic dental procedures. The use of plain solutions or those with a vasoconstrictor concentration of 1:200,000 (as opposed to 1:50,000 or 1:100,000) will minimize this possibility. Secondly, as mentioned above, vasoconstrictor containing solutions are more acidic. The more concentrated the vasoconstrictor is, the more acidic the local anesthetic solution will be. This is primarily due to the anti-oxidant preservative for the vasoconstrictor, sodium metabisulphite. In areas of infection, both periodontal and periapical, the pH of the infected tissue is acidic. Injecting acidic local anesthetic into this environment will favour the charged local anesthetic molecule over the neutral molecule (both of which exist in solution). It is the neutral molecule that is required to pass through the nerve sheath membrane. If there are not enough of these neutral molecules, as would be the case in this scenario, complete anesthesia may be difficult to achieve. Solutions without vasoconstrictor may avoid this problem, as they are more neutral in pH. When injected into this acidic environment, more neutral molecules are available to cross the nerve membrane and inhibit nerve conduction. This same phenomenon can occur by injecting too much local anesthetic with vasoconstrictor into the same area. In this scenario, imagine giving an inferior alveolar nerve block using a local anesthetic with vasoconstrictor concentration of 1:100,000 (the pH will be less than 5). If the block fails, the operator may decide to re-inject using the same formulation. If there is still a lack of complete anesthesia, injecting more of this solution may not lead to successful anesthesia because of the acidification of the area. The neutral molecules required to pass through the nerve membrane may not exist. The answer in this situation is to use a plain solution or one with 1:200,000 epinephrine after the first failed block to minimize the acidity created following injection.

The final reason to consider the limitation of vasoconstrictor is for those patients who are sensitive to the injection of epinephrine. There are some people who exhibit palpitations after a local anesthetic injection. This feeling can lead to anxiety and syncope. For these patients, it is prudent to limit the amount of vasoconstrictor used by choosing a plain solution or one with minimal vasoconstrictor concentration.

Contraindications and Precautions

There are few absolute contraindications for local anesthetics. Most are relative contraindications indicating that doses should be limited. One absolute contraindication for the use of prilocaine is allergy. Although allergies to amide local anesthetics are very rare, it is possible. It is more likely that the patient is allergic to the bisulphite anti-oxidant required for the vasoconstrictor. Patients with sulphite allergies will usually report this in their medical history. These people tend to have a higher incidence of asthma. If a sulphite allergy is present, prilocaine without vasoconstrictor may be used. If the patient reports an allergy to a local anesthetic, it is important to determine if the reaction was psychogenic or truly allergic. If allergy is suspected, testing by an allergist is warranted. The dentist should request testing two or three different amide local anesthetics and sodium metabisulphite as well.

Local anesthetics should also be used with caution in patients with epilepsy since these drugs lower the seizure threshold. This is especially a concern in children during sedation with an antihistamine and narcotic combination. As well, caution should be exercised in those with liver disease such as hepatitis or alcohol-induced cirrhosis. These patients may not be able to effectively metabolize amide local anesthetics.

Another precautionary measure to consider is that local anesthetic solutions that are supplied as a 4% concentration may have a higher risk of neurotoxicity. A retrospective study done by Haas et al. suggested that both articaine and prilocaine have a higher incidence of inducing permanent lip and or tongue paresthesia following inferior alveolar nerve block injections after non-surgical dental visits. From 1973 to 1993, there were 143 cases of non-surgically induced paresthesia. In 1993 there were 14 cases of paresthesia. Articaine was used in 10 cases and in 4 of the cases, prilocaine was used. It was estimated from this study that during the year 1993, there was a 1.7 in one million chance that prilocaine would cause a permanent lip or tongue paresthesia. There was a 2.27 in one million chance for articaine. In a second study, Pogrel et al. reported 12 people who presented to a university dental setting over a 4-year period. These people complained of paresthesia following non-surgical dental appointments. Eight of these patients received lidocaine with epinephrine and 3 of them received prilocaine. This study took place before articaine was released into the American marketplace and it must be realized that lidocaine was used much more frequently than prilocaine. An industry estimate during this time (mid 1990’s) suggested that lidocaine had 60% of the marketplace, mepivacaine 30% and prilocaine...
local anesthetics can produce effective pulpal anesthesia, and stock one type of local anesthetic in their practice. As all amide The choice of which local anesthetic to use can be confusing. Extra vigilance practitioners should not administer levels of prilocaine To avoid causing drug-induced methemoglobinemia, prilocaine, articaine and benzocaine should be avoided. In patients with congenital methemoglobinemia, this manifests as the patient appearing cyanotic, usually in the nail beds and lips, a few hours after the causative drug is administered. There are no cardiac or respiratory abnormalities. Supplemental oxygen does not abolish the cyanosis because the hemoglobin cannot pick up the oxygen. If severe, this can lead to hypoxia and death. Treatment is the intravenous administration of methylene blue in a hospital. This reverses the problem quite readily. Doses of greater than 400 mg of prilocaine have been shown to very rarely cause methemoglobinemia. In patients with congenital methemoglobinemia, prilocaine, articaine and benzocaine should be avoided. To avoid causing drug-induced methemoglobinemia, practitioners should not administer levels of prilocaine above the recommended maximum dose. Extra vigilance should occur for very small children where toxic levels can be achieved with just over one cartridge (Figure 9).

Pregnancy and Nursing
The safe use of prilocaine in pregnant women has not been established. However, prilocaine and lidocaine carry the best rating for safety in pregnant patients as suggested by the Food And Drug Administration. The dentist should weigh the safety of giving a local anesthetic to pregnant individuals with the potential risks of long-term infection and pain resulting in the use of antibiotics and analgesics for prolonged periods. As well, consideration should be given to minimizing the total dose of local anesthetic. Since prilocaine is a 4% solution and lidocaine is a 2% solution, lidocaine might be preferred. Careful aspiration should also be paramount.

In nursing mothers, prilocaine might be secreted in the breast milk in very small amounts. This generally should not affect the nursing baby.

Summary
Many studies show that prilocaine is as effective as any amide local anesthetic in the marketplace for adults and children. The choice of which local anesthetic to use can be confusing. This author has encountered many practitioners who only stock one type of local anesthetic in their practice. As all amide local anesthetics can produce effective pulpal anesthesia, and because they are all safe to use in the vast majority of patients, there is some justification for only using one type of local anesthetic. However, the choice of which product to use might be decided upon by considering the duration of pulpal anesthesia required. This is where prilocaine may be of advantage. It can produce maximum pulpal anesthesia with minimal vasoconstrictor use, or it can provide short duration pulpal anesthesia with no vasoconstrictor use. As well, there are advantages as mentioned above, to limiting or even completely eliminating vasoconstrictor from the local anesthetic solution. The patient's medical history, acidification of tissues and pulpal insult are some of the factors to consider. Prilocaine is an effective drug to add to ones local anesthesia armamentarium.

References:

Author Profile
David Isen, DDS, BSc
Dr. David Isen is a graduate of the University of Western Ontario, Faculty of Dentistry. David is Past President of the Ontario Dental Society of Anesthesiology, a Fellow of The Academy of Dentistry International and recently received fellowships in the International College of Dentists and The Pierre Fauchard Academy. He has lectured with the Ontario Dental Association and the University of Western Ontario’s Continuing Education Programs, speaking on topics relating to local anesthesia and nitrous-oxide sedation. He also lectures at the Faculty of Dentistry of the University of Toronto. Dr. Isen reviews articles for The Journal of The American Dental Society of Anesthesiology, Anesthesia Progress and for The Journal of the Canadian Dental Association.

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Questions

1. _______ was the first local anesthetic used in medicine.
   a. Ether
   b. Procaine
   c. Epinephrine
   d. Cocaine

2. The first use of a local anesthetic took place in _______.
   a. 1883
   b. 1884
   c. 1885
   d. 1893

3. Dr. William Halstead, a dentist, used _______ in an effort to block the hemimandible.
   a. cocaine and HCl
   b. cocaine and sodium
   c. cocaine and citric acid
   d. cocaine and boiling water

4. _______ was/were the reason(s) a substitute for cocaine was needed.
   a. Addiction
   b. Inhalation
   c. Cost
   d. a & b

5. Procaine was synthesized in _______.
   a. 1901
   b. 1903
   c. 1904
   d. 1905

6. _______ is an undesirable property of both cocaine and procaine.
   a. Long onset of action
   b. Short duration of action
   c. Relatively high allergenicity
   d. all of the above

7. The first amide-based local anesthetic was _______.
   a. lidocaine
   b. marcaine
   c. carbocaine
   d. none of the above

8. The two classifications of injectable local dental anesthetics are _______.
   a. amides and esters
   b. bromides and esters
   c. esters and sulphones
   d. amides and sulphones

9. Prilocaine can be used as a _______.
   a. sedative
   b. inhalation
   c. general anesthetic
   d. local anesthetic*

10. The lipophilic nature of local anesthetic is desirable because _______.
    a. it is able to diffuse through the lipid membrane layer of the nerve sheath
    b. it lessens the stinging sensation at the injection site
    c. it increases the duration of the anesthetic
    d. one of the above

11. In the US prilocaine is marketed as a _______.
    a. 1%
    b. 2%
    c. 3%
    d. 4%

12. The concentration of epinephrine in a frequently-used prilocaine local anesthetic (Citanest Forte) is _______.
    a. 1:150,000
    b. 1:200,000
    c. 1:250,000
    d. 1:300,000

13. The pH of prilocaine (Citanest) without epinephrine is _______.
    a. 3.0–4.0
    b. 4.0–5.0
    c. 5.0–6.0
    d. 6.0–7.0

14. The pH of prilocaine with epinephrine (Citanest) is _______.
    a. 1.5–2.5
    b. 2.5–3.5
    c. 3.5–5.5
    d. 5.5–7.5

15. The onset of action for infiltration anesthesia in the maxilla for prilocaine with epinephrine is _______.
    a. 1 minute
    b. 2 minute
    c. 3 minute
    d. 4 minute

16. The duration for soft tissue anesthesia with Citanest Dental (epinephrine) is _______.
    a. 2 hours
    b. 3 hours
    c. 4 hours
    d. None of the above

17. The duration of maxillary pulpal anesthesia with Citanest Dental (no vasoconstrictor) is _______.
    a. 5 minutes
    b. 10 minutes
    c. 15 minutes
    d. 20 minutes

18. Prilocaine is metabolized in the _______.
    a. kidneys
    b. liver
    c. lungs
    d. all of the above*

19. The _______ does not/do not metabolize prilocaine.
    a. liver
    b. kidneys
    c. pancreas
    d. lungs

20. The excretion of prilocaine is through the _______.
    a. pancreas
    b. liver
    c. kidneys
    d. none of the above

21. Prilocaine is removed from the circulatory system for renal clearance _______.
    a. at about the same rate as other amides.
    b. slower than other amides.
    c. faster than other amides.
    d. none of the above

22. When maximum doses are printed, they are done so for the average, healthy adult weighing _______.
    a. 70 kg
    b. 75 kg
    c. 80 kg
    d. 85 kg

23. The maximum dose of prilocaine for one appointment for a healthy average 70 kg adult is _______.
    a. 200 mg
    b. 300 mg
    c. 400 mg
    d. 500 mg

24. The American Academy of Pediatric Dentistry suggests _______ of amide local anesthetic be given to pediatric patients.
    a. no more than 3 mg/kg
    b. no more than 4 mg/kg
    c. no more than 5 mg/kg
    d. no more than 6 mg/kg

25. The maximum number of cartridges of Citanest, with or without epinephrine, for an adult (70 kg) is _______.
    a. 6.9
    b. 5.9
    c. 4.9
    d. 7.9

26. According to the author, the advantage of Citanest Dental with epinephrine over other amide anesthetics with vasoconstrictor is that it _______.
    a. contains more epinephrine than other amides
    b. contains half the epinephrine of other amides
    c. has the same amount of epinephrine
    d. none of the above

27. Vasoconstrictor-containing solutions are more acidic because the vasoconstrictor contains _______.
    a. sodium metabisulphite
    b. sodium chloride
    c. a and b
    d. none of the above

28. _______ is an absolute contraindication for the use of prilocaine.
    a. Periodontitis
    b. Anemia
    c. Allergy
    d. Asthma

29. Local anesthetics should be used with caution in patients with epilepsy because they _______.
    a. lower the seizure threshold
    b. raise the seizure threshold
    c. neutralize the seizure threshold
    d. increase the frequency of seizures

30. _______ is one of the symptoms of methemoglobinemia.
    a. Hyperactivity
    b. Anxiety
    c. Cyanotic appearance, usually in the nail beds and lips
    d. Depression
## Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

<table>
<thead>
<tr>
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<td>Yes</td>
<td>No</td>
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<tr>
<td>Objective #4:</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

2. To what extent were the course objectives accomplished overall?  
   5 | 4 | 3 | 2 | 1 | 0

3. Please rate your personal mastery of the course objectives.  
   5 | 4 | 3 | 2 | 1 | 0

4. How would you rate the objectives and educational methods?  
   5 | 4 | 3 | 2 | 1 | 0

5. How do you rate the author's grasp of the topic?  
   5 | 4 | 3 | 2 | 1 | 0

6. Please rate the instructor's effectiveness.  
   5 | 4 | 3 | 2 | 1 | 0

7. Was the overall administration of the course effective?  
   5 | 4 | 3 | 2 | 1 | 0

8. Do you feel that the references were adequate?  
   Yes | No

9. Would you participate in a similar program on a different topic?  
   Yes | No

10. If any of the continuing education questions were unclear or ambiguous, please list them.

11. Was there any subject matter you found confusing? Please describe.

12. What additional continuing dental education topics would you like to see?

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## Requirements for successful completion of the course and to obtain dental continuing education credits:

1. Read the entire course.
2. Complete all information above.
3. Complete answer sheets in either pen or pencil. Mark only one answer for each question.
4. A score of 70% on this test will earn you 2 CE credits.
5. Complete the Course Evaluation below. Make check payable to PennWell Corp. for Questions Call 216.398.7822.

## Mail completed answer sheet to

Academy of Dental Therapeutics and Stomatology,  
A Division of PennWell Corp.  
P.O. Box 116, Chesterland, OH 44026  
or fax to: (440) 845-3447

## Educational Objectives

1. List and describe available local anesthetics and their chemical components.
2. Review the considerations involved in selecting a local anesthetic.
3. List the recommended doses of local anesthesia for adults and children.
4. List and describe complications that can arise from use of local anesthetics.

## Course Evaluation and Participant Feedback

We encourage comments and feedback pertaining to all courses. Please use the answer sheets or address above to express your thoughts or wishes.

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## Please Photocopy Answer Sheet for Additional Participants.

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## Author Disclaimer

The author of this course has no commercial ties with the sponsors or the providers of the unrestricted educational grant for this course.

This course was made possible through an unrestricted educational grant. No manufacturer or third party has had any input into the development of course content. All content has been derived from references and or the opinions of clinicians. All content has been derived from references and or the opinions of clinicians.

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Many PennWell self-study courses have been approved by the Dental Assisting National Board, Inc. (DANB) and can be used by dental assistants who are DANB Certified to meet continuing education requirements. PennWell is a California Provider. The California provider number is 4527. The cost for courses ranges from $49.00 to $110.00.

Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell in writing.

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## Answer Sheet

Name:  
Title:  
Specialty:  
Address:  
E-mail:  
State:  
ZIP:  
City:  
Telephone: Home ( ) Office ( )

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## Course Evaluation

Please evaluate this course by responding to the following statements, using a scale of Excellent = 5 to Poor = 0.

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## Record Keeping

PennWell maintains records of successful completion of any course. Please contact our customer service department at 1-800-FOR-DANB, ext. 445. PennWell is willing to supply a verification statement of your successful completion of any course. Please contact our customer service department at 1-800-FOR-DANB, ext. 445.

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## Cancellation/Refund Policy

Any participant who is not 100% satisfied with this course can request a full refund by contacting PennWell in writing.

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## CES CREDITS COST

AGD Code 132

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Customer Service 216.398.7822

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