

Survey of Local Anesthetic Use by Ontario Dentists

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ABSTRACT

Objective: Local anesthetics are believed to be the most frequently used drugs in clinical dentistry, and although they are generally regarded as safe, some adverse reactions can be expected and do occur. The purpose of this study was to obtain, by means of a mail survey, information on the types and amounts of local anesthetics used by Ontario dentists during 2007.

Materials and Methods: A survey requesting data on the annual use of injectable local anesthetics was mailed to all 8,058 dentists licensed by the Royal College of Dental Surgeons of Ontario in 2007.

Results: The effective response rate to the single mailing was 17.3% (1,395 respondents). By extrapolation, the estimated use of local anesthetics by all Ontario dentists during 2007 was determined to be about 13 million cartridges, which represents an average of 1,613 cartridges per dentist per year. Lidocaine with epinephrine 1:100,000 was the most commonly used formulation with 37.31% of total anesthetic use, followed by articaine with 1:200,000 epinephrine (27.04%) and articaine with 1:100,000 epinephrine (17.16%). Overall, local anesthetics combined with a vasoconstrictor accounted for more than 90% of total anesthetic use. A minority of survey respondents (15.68%) indicated that their pattern of anesthetic use had changed significantly in the past few years. Patterns of use were similar for early and late survey respondents. These data provide a current account of the use of local anesthetics by Ontario dentists.

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Local anesthetics are believed to be the most frequently used drugs in clinical dentistry. It has been estimated that over 300 million cartridges of local anesthetic are administered annually by dentists in the United States.¹

Chemically, local anesthetic drugs share certain structural properties, including a hydrophilic group joined to an intermediate carbon chain, which is in turn joined by an amide or ester linkage to a lipophilic group.² In Canada, all injectable local anesthetic drugs currently licensed for preparation in dental

cartridges are members of the amide class. Alphabetized by generic name, these drugs are articaine, bupivacaine, lidocaine, mepivacaine and prilocaine.

With respect to their mechanism of activity, local anesthetics prevent the propagation of action potentials in nerves by diffusing through the lipid-rich nerve cell membrane and blocking the transport of sodium ions by channels into the nerve cell membrane. This prevents the transient increase in neuronal membrane permeability required for an action potential to occur.^{2,3}

Local anesthetics used in dentistry are generally regarded as safe, and the incidence of adverse events associated with their administration is assumed to be low. However, given the large number of injections of local anesthetics administered by dentists, some adverse reactions to these drugs can be expected and do occur. These reactions may be local or systemic in nature.⁴

In Ontario, there is no oversight by regulatory bodies with regard to the overall frequency of use of local anesthesia in dental treatment. Furthermore, accurate data on the relative use of various formulations of local anesthetic marketed in dental cartridges are not publicly available. Current information on the overall use of local anesthesia in dentistry, as well as the relative market share of the different anesthetic agents, could be useful during periodic re-evaluations of the safety of these drugs. The purpose of this study was to obtain, by means of a mail survey, information on the types and amounts of local anesthetics used by Ontario dentists during 2007.

Materials and Methods

In February 2008, a covering letter, survey and addressed return envelope were mailed to all 8,058 dentists licensed by the Royal College of Dental Surgeons of Ontario. The covering letter and survey form (**Appendix 1**) were based on an earlier survey.⁵ Dentists were asked to indirectly estimate their recent annual use of local anesthetic (for the year 2007) by a method of their own choosing, such as purchasing or ordering records. They were also asked whether their pattern of local anesthetic use had changed in the past 2 years and, if so, what changes had been made and why.

Reminders and follow-up survey mailings, which are generally advisable for a study of this type, were not sent because the initial mailing was sent to all Ontario dentists (rather than a sample) and the number of responses received from the first mailing was deemed adequate.

On the survey form, both generic and trade names of drugs were listed to aid respondents in the recognition of specific anesthetic agents. Practitioners were asked to return the survey even if they had used no local anesthetics during 2007 or if another dentist from the same facility was to respond on behalf of the facility. Measures were taken to rule out double-counting of responses.

Data were entered into a spreadsheet as received and were subjected to descriptive statistical analysis. The following variables were investigated: survey response rate, the amounts and types of anesthetic solutions used annually, the percentage of dentists whose pattern of local anesthetic use had changed significantly in the past 2 years and the reasons for these changes. The amounts and types of anesthetic solutions used annually were determined from the survey responses and were extrapolated to all Ontario dentists. In addition, these response

Table 1 Raw survey results classified by drug formulation

Local anesthetic formulation	No. (%) of cartridges used in 2007
Articaine 4% with epinephrine 1:100,000	386,165 (17.16)
Articaine 4% with epinephrine 1:200,000	608,426 (27.04)
Bupivacaine 0.5% with epinephrine 1:200,000	15,354 (0.68)
Lidocaine 2% with epinephrine 1:100,000	839,434 (37.31)
Lidocaine 2% with epinephrine 1:50,000	53,801 (2.39)
Mepivacaine 2% with epinephrine 1:100,000	35,070 (1.56)
Mepivacaine 2% with levonordefrin 1:20,000	32,049 (1.42)
Mepivacaine 3% plain	126,581 (5.63)
Prilocaine 4% with epinephrine 1:200,000	68,509 (3.04)
Prilocaine 4% plain	84,735 (3.77)

data were grouped and analyzed by local anesthetic drug and by vasoconstrictor drug.

To assess the accuracy of data extrapolations to all Ontario dentists and the possibility of differences between nonresponders and responders to the survey, differences in survey results between early responders (first 350) and late responders (final 350; believed to be similar to nonresponders⁶) were compared. More specifically, the percentage of each anesthetic drug used within a given survey response was tabulated, and Mann-Whitney *U* tests were performed to determine whether proportional anesthetic drug use differed across the first and last 350 responses received. Statistical tests were 2-tailed and were interpreted at the 5% level. Data on local anesthetic use from this survey were also compared with the results of a 1993 survey conducted in the same province.⁵

Ethics approval for this study was obtained from the University of Toronto Health Sciences Research Ethics Board.

Results

Of 8,058 surveys sent, the raw number of survey responses received was 1,084, including 70 blank responses from dentists who stated that the requested information would be provided by another dentist at the same facility. For an additional 381 dentists who did not respond directly with any numeric information, data were supplied by another dentist at the same facility. The effective number of survey responses was therefore 1,395 (effective response rate 17.3%). A further 24 survey responses could

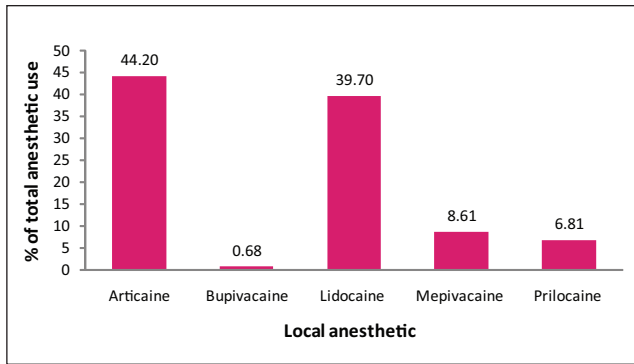


Figure 1: Distribution of reported use by local anesthetic drug. Extrapolated annual use for all Ontario dentists: articaine = 5,745,100 cartridges, bupivacaine = 88,690 cartridges, lidocaine = 5,159,633 cartridges, mepivacaine = 1,118,878 cartridges, prilocaine = 885,190 cartridges.

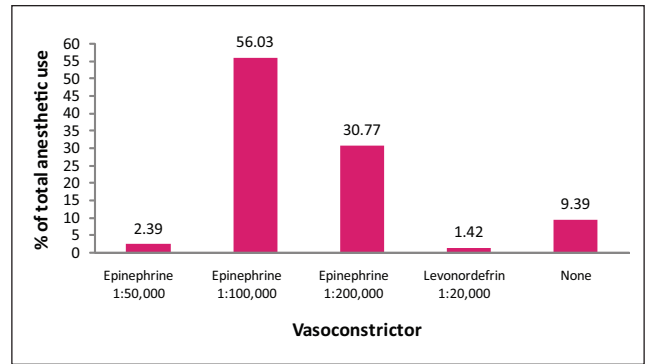


Figure 2: Distribution by vasoconstrictor. Extrapolated annual use for all Ontario dentists: epinephrine 1:50,000 = 310,773 cartridges, epinephrine 1:100,000 = 7,282,058 cartridges, epinephrine 1:200,000 = 3,998,899 cartridges, levonordefrin 1:20,000 = 185,126 cartridges, no vasoconstrictor = 1,220,634 cartridges.

Table 2 Use of drugs by early and late survey respondents

Local anesthetic drug	Time of response; % distribution		p value ^a
	First 350 respondents	Last 350 respondents	
Articaine	43.18	44.86	0.52
Bupivacaine	0.73	0.43	0.99
Lidocaine	38.93	40.91	0.46
Mepivacaine	9.91	8.49	0.70
Prilocaine	7.25	5.31	0.88

^aMann-Whitney U test comparing the proportional use of each drug by early and late respondents. There were no statistically significant differences for any of these drugs.

not be used because the respondent was either unable or unwilling to provide the requested information.

The total number of cartridges of local anesthetic used in 2007 by the Ontario dentists who participated in the survey was calculated to be 2,250,124, which represents an average of 1,613 cartridges per dentist. Extrapolation to all Ontario dentists led to an estimate of 12,997,490 cartridges used during 2007.

Lidocaine 2% with epinephrine 1:100,000 was the most commonly used formulation, representing 37.31% of total anesthetic use (Table 1). The next most commonly used formulations were articaine 4% with epinephrine 1:200,000 (27.04%) and articaine 4% with epinephrine 1:100,000 (17.16%).

When results were categorized by local anesthetic drug (rather than formulation) and extrapolated to all Ontario dentists, articaine and lidocaine were by far the most popular local anesthetic drugs (Fig. 1). Formulations incorporating articaine accounted for 44.20% of total anesthetic use, whereas those incorporating lidocaine accounted for 39.70% of total use.

Results categorized by vasoconstrictor are shown in Fig. 2. Formulations with epinephrine 1:100,000 were most common (56.03%), followed by those containing epinephrine 1:200,000 (30.77%). Plain local anesthetics

were administered slightly less than one-tenth of the time (9.39%).

Of the 1,084 respondents who provided completed surveys, 170 (15.68%) stated that they had changed their pattern of local anesthetic use significantly in the past 2 years, whereas 914 (84.32%) had not. Among the 170 positive responses, the most frequent changes reported were reduction or discontinuation of use of some or all of the 4% solutions for nerve block injections (90 responses) and altered use of bupivacaine 0.5% with epinephrine 1:200,000 because of lack of availability of this specific formulation in dental cartridge format (21 responses). All other explanations were reported at smaller frequencies, and no remarkable trends were noticeable.

Although more than 1,000 survey responses were received, the accuracy of extrapolating the data to all Ontario dentists might be questioned. It was therefore of interest to determine if respondents differed from non-respondents in any significant way. It has been suggested that late respondents are more similar to nonrespondents than are early respondents.⁶ As such, the proportions of specific local anesthetic drugs used by early respondents (first 350) and late respondents (final 350) were compared. For each drug, the proportion used by early and late respondents differed by less than 2 percentage

Table 3 Comparison of 1993 and 2007 survey results by local anesthetic drug

Local anesthetic drug	% of total anesthetic use		Change from 1993 to 2007 (percentage points)
	1993 survey ^a	2007 survey	
Articaine	37.84	44.20	+6.36
Bupivacaine	2.08	0.68	-1.40
Lidocaine	26.35	39.70	+13.35
Mepivacaine	13.49	8.61	-4.88
Prilocaine	20.23	6.81	-13.42

^aData from Haas and Lennon.⁵

Table 4 Comparison of 1993 and 2007 survey results by vasoconstrictor

Vasoconstrictor	% of total anesthetic use		Change from 1993 to 2007 (percentage points)
	1993 survey ^a	2007 survey	
Epinephrine 1:50,000	2.97	2.39	-0.58
Epinephrine 1:100,000	42.16	56.03	+13.86
Epinephrine 1:200,000	38.35	30.77	-7.58
Levonordefrin 1:20,000	6.35	1.42	-4.93
None	10.16	9.39	-0.77

^aData from Haas and Lennon.⁵

points (Table 2). Furthermore, use of the Mann-Whitney *U* test to compare the proportions of each anesthetic drug used by early and late respondents revealed no statistically significant differences between these 2 groups. These results suggested that there was little difference in the choice of anesthetic drugs between early and late respondents, which formed the basis for extrapolating these survey results to all dentists in the province.

A comparison of the 2007 results with those obtained in 1993 showed that the overall number of cartridges used annually per Ontario dentist was down slightly (from 1,854 to 1,613). It appeared that the relative use of articaine and lidocaine by Ontario dentists increased from 1993 to 2007 (Table 3). In contrast, the relative use of formulations containing bupivacaine, mepivacaine and prilocaine appeared to have decreased. As for vasoconstrictors, relative use of formulations containing epinephrine 1:100,000 increased from 1993 to 2007, whereas there was little change in the relative use of formulations without vasoconstrictor (Table 4).

Discussion

Many surveys solicit information that is readily available to respondents or that pertains to respondents' attitudes and values. Completion of the survey used in the study reported here required extra effort, as dentists were

asked to calculate their annual anesthetic usage on the basis of a method of their own choosing. The indirect methods of calculation used in completing this survey probably struck a good balance between data accuracy and practicality for the responding dentists.⁵ These methods might have involved, for example, calculating estimated anesthetic usage during an average work week or tracking down ordering records or invoices. Further effort was requested of dentists working in multipractitioner offices to coordinate responses and avoid duplication. Hence, the effective response rate of 17.3% was not unreasonable relative to the response rates of other recent surveys of Canadian dentists.^{7,8}

In survey research, especially when the response rate is low, there may be concerns about nonresponse bias. However, there is also evidence to suggest that significant nonresponse bias is unlikely in surveys of homogeneous populations.⁹ More specifically, when homogeneous, well-educated professional groups such as physicians or dentists are surveyed, the conclusions based on data gathered from a single mailing are typically the same as those based on data gathered from multiple mailings.^{10,11} Indeed, an earlier survey of local anesthetic use by Ontario dentists employed multiple techniques to show that no significant nonresponse bias was present.⁵ The lack of clinically meaningful or statistically significant differences in use of anesthetic drugs between early and

late respondents to this survey suggests that nonresponse bias was likely minimal. Given the subject matter of the survey, the suspected lack of bias is not surprising, even though the response rate was relatively low.^{5,6}

From 1993 to 2007, there were some changes in patterns of overall use of local anesthesia by Ontario dentists. The total number of anesthetic cartridges used annually increased from roughly 11 million to 13 million, whereas the number of cartridges used per dentist decreased from 1,854 to 1,613. Although the topic has not been heavily researched, it appears that many factors influence a dentist's decision to use local anesthetic in any specific case, including procedure type, tooth type, patient-specific factors (such as ethnicity and age) and dentist-specific factors.¹²⁻¹⁴ Interestingly, over the period 1983 to 1999 in Australia, the average number of patient visits per year and per hour for general dentists decreased,¹⁵ whereas the rates of certain diagnostic and preventive procedures typically carried out by dentists without the use of local anesthetic increased.¹⁶ Similar changes in dental practice trends in Ontario might explain the temporal decrease in the average number of anesthetic cartridges used annually by Ontario dentists.

Limited previous research has focused on the criteria that influence dentists' selection of specific anesthetic formulations. In one study, the most frequently mentioned criteria were efficacy, procedure and availability.¹⁷ Although it is reasonable to state that all available amide anesthetics are similarly efficacious,^{2,3} the type and duration of the procedure should certainly be taken into account when choosing a local anesthetic formulation. Most of the currently available anesthetic solutions are of intermediate duration, but bupivacaine is a long-acting anesthetic, whereas formulations of mepivacaine and prilocaine without vasoconstrictor are short-acting.⁵ Availability of particular formulations was an issue relevant to this survey, as several dentists reported using 0.5% bupivacaine with epinephrine 1:200,000 from multidose vials during at least part of 2007 because they had been unable to obtain the product in standard dental cartridges. Reasons for changes in the relative use of different formulations from 1993 to 2007 were hard to pinpoint, but might have included available clinical practice guidelines¹⁸ and current evidence on the use of vasoconstrictors.¹⁹

Among the 15.68% of respondents whose pattern of local anesthetic use had changed in the 2 years before the survey, the most frequently mentioned changes were reduction or discontinuation of use of some or all of the 4% solutions for nerve block injections and altered use of bupivacaine 0.5% with epinephrine 1:200,000 because of lack of availability of this formulation in dental cartridge format. A variety of other explanations for changes in patterns of use were reported at smaller frequencies (<2% of total responses): increase or decrease

in overall use of anesthetics, changes in injection technique, changes in anesthetic choice because of cost, and short-term changes in drug choice related to in-house availability. Given this information, it may be reasonable to assume that the total number of cartridges used by Ontario dentists during 2006 and 2007 was similar. Furthermore, given that reports of a reduction in use of 4% solutions for mandibular block probably stemmed from a Royal College of Dental Surgeons of Ontario Practice Alert²⁰ that was published in the summer of 2005 and given that the overall relative use of bupivacaine is traditionally very low,⁵ there is a reasonable basis to assume that the *relative* use of various local anesthetic drugs during 2006 and 2007 was also similar. Given the absence of factors that would appreciably change anesthetic use patterns, the overall and relative use of these drugs by Ontario dentists was probably similar during 2008 as well.

Local anesthetics remain dentistry's most important drugs.³ This report has provided information on the use of local anesthetics by Ontario dentists during 2007. Although local anesthetics are the safest and most effective drugs for pain control in medicine,³ data relating to the amount and types of anesthetics used by dentists could prove useful during any postmarket reassessment of the benefit-risk profiles of these agents. ✦

THE AUTHORS



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Appendix 1: Cover letter and survey data form mailed to all dentists licensed by the Royal College of Dental Surgeons of Ontario in early 2008



Faculty of Dentistry
University of Toronto

Dr. Daniel Haas
Professor and Head of Dental Anaesthesia

SURVEY OF LOCAL ANAESTHETIC USE

Dear Colleague,

This survey is being conducted by Dr. Andrew Gaffen and Dr. Daniel Haas of the Faculty of Dentistry, University of Toronto. The purpose of the survey is to determine the types and amounts of injectable local anaesthetic formulations used annually by Ontario dentists. Your assistance in providing this information will be most valuable and greatly appreciated.

The yearly use of local anaesthetics may be determined indirectly by calculating the number of cartridges (or "carpules") purchased for each dental office (or facility) in a recent one year period. You may wish to answer this survey by calculating the number of cartridges purchased for your office/facility during 2007 from invoices or ordering records. Alternatively, you may use any other method which accurately reflects your recent one-year usage, and if so, please indicate the method used.

To avoid duplication, only one completed Data Form (please see the other side) should be submitted for each dental office/facility. If another dentist will be providing the data for your office(s), please indicate this in the appropriate space at the bottom of the next page, leave the rest blank, and still return this survey. If you purchase local anaesthetics for more than one office, you may include all of the data on one form, provided that this same information will not be duplicated by another dentist. Even if you do not use any local anaesthetics in your practice, please mark this on the appropriate line on the other side, and return the survey. Please ensure that someone takes responsibility for providing data on local anaesthetic use for each location where you practise.

The Data Form lists the names of local anaesthetic formulations available for use in dental syringes. They are listed alphabetically by generic name, followed by some of their common trade names, in parentheses. Information should be recorded in the appropriate space on the Data Form for all injectable local anaesthetics purchased for your office(s) in one year.

Your name has been requested only to permit a follow-up in the event that you do not return this form. **Your personal response will be kept strictly confidential.** Only the cumulative data will appear in any reports.

Please return this survey in the addressed envelope before April 1, 2008.

Your cooperation and your time devoted to this are greatly appreciated.

Sincerely,

A handwritten signature in black ink that reads "Daniel Haas".

Daniel Haas, DDS, PhD, FRCD(C)

Please complete the other side.

DATA FORM

YOUR NAME: _____ RCDSO REGISTRATION #: _____

LOCAL ANAESTHETIC:

(listed alphabetically by generic name)

Number of cartridges used annually:

-articaine 4% with epinephrine 1:100,000
(Ultracaine DS Forte, Zorcaine, Septanest SP, Astracaine) _____

-articaine 4% with epinephrine 1:200,000
(Ultracaine DS Forte, Septanest N, Astracaine) _____

-bupivacaine 0.5% with epinephrine 1:200,000
(Marcaine) _____

-lidocaine 2% with epinephrine 1:100,000
(Xylocaine, Octocaine 100, Lignospan Standard) _____

-lidocaine 2% with epinephrine 1:50,000
(Xylocaine, Octocaine 50, Lignospan Forte) _____

-mepivacaine 2% with epinephrine 1:100,000
(Scandonest 2% Special) _____

-mepivacaine 2% with levonordefrin 1:20,000
(Carbocaine, Isocaine 2%, Polocaine 2%) _____

-mepivacaine 3% plain
(Carbocaine, Scandonest 3% Plain, Isocaine 3%, Polocaine 3%) _____

-prilocaine 4% with epinephrine 1:200,000
(Citanest Forte) _____

-prilocaine 4% plain
(Citanest Plain) _____

-other (list name(s)) _____
Do not include data on topical anaesthetics (pastes, sprays)

Have you changed your pattern of local anaesthetic use significantly in the last 2 years? Yes/No
If so, what change(s) have you made and why? _____

If you are responding on behalf of other dentists in your office, please indicate their names: _____

If the Data Form above is left blank, please check which one of the following applies:
-You did not use any local anaesthetic in 2007: _____ or
-You did use local anaesthetic in 2007, but the data will be provided by another dentist: name of dentist(s) _____

Thank you for your time and cooperation.