

A survey of sodium hypochlorite use by general dental practitioners and endodontists in Australia

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Abstract

Background: Sodium hypochlorite is used commonly as an endodontic irrigant, but there are no published reports that provide details of its use. This survey sought to determine the percentage of Australian dentists who practiced endodontics, whether they used sodium hypochlorite for irrigation, and the manner of dilution, storage and dispensing sodium hypochlorite used by both dentists and endodontists.

Methods: All Australian endodontists and a stratified random sample of 200 general dentists in Australia were surveyed to address the issues identified above.

Results: Almost 98 per cent of dentists surveyed performed endodontic treatment. Among endodontists, nearly 94 per cent used sodium hypochlorite for irrigation compared with just under 75 per cent of general dentists. Sodium hypochlorite use by general dentists was more common in Victoria and South Australia than in other States. An infant sanitizer (Milton or Johnson's Antibacterial Solution) was used by just over 92 per cent of general practitioners and by more than 67 per cent of endodontists. All other respondents used domestic bleach. One hundred and sixty four of the respondents (80 per cent of endodontists and over 90 per cent of general dentists) used a 1 per cent w/v solution. Ten practitioners used a 4 per cent w/v solution, five used a 2 per cent w/v solution and four used a 1.5 per cent w/v solution. Eighty per cent of the practitioners who diluted their sodium hypochlorite before use, used demineralized water for this purpose. The remainder used tap water. Only four practitioners stored sodium hypochlorite in a manner which risked light exposure and loss of available chlorine content.

Conclusions: Sodium hypochlorite is commonly used as an endodontic irrigant and Australian dentists generally stored the material correctly.

Key words: Survey, endodontics, sodium hypochlorite, bleach, concentration, storage.

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INTRODUCTION

The use of sodium chlorite as an irrigant in endodontics is widespread and it is used commonly as a baseline against which other endodontic irrigants are assessed.¹⁻⁴ The broad acceptance of sodium hypochlorite for endodontic irrigation is due principally to its anti-microbial and tissue dissolving capabilities,⁵⁻⁷ although the low cost of this material may play some part in its popularity.⁸ However, sodium hypochlorite solutions are unstable. Exposure to light, heat, air, metals and organic substances can lower the available chlorine concentration with concomitant loss of anti-microbial and tissue dissolving properties.^{9,10} Recent research has identified the effect these factors exert on sodium hypochlorite in the dental practice environment.¹¹ However, the authors are unaware of any study that has examined whether the storage and handling of sodium hypochlorite solutions in dental practices is undertaken satisfactorily to minimize a loss of activity from environmental factors. In addition, the actual incidence of sodium hypochlorite use in endodontics has not been investigated, and there are no recent data on the proportion of general dentists who include endodontics in their practices.

Therefore, the aim of this study was to survey Australian general dentists and endodontists on whether endodontic treatment was performed in their practices and the manner in which sodium hypochlorite solutions were used.

MATERIALS AND METHODS

The survey form used in this study is shown in Fig 1 and the survey group selection procedure is detailed below. All responses were recorded on individual survey forms for each dentist. For specialist group

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1. Do you do endodontics (root fillings/root canals) in your practice?
 - k Yes
 - k No No further questions
 2. Do you use Sodium Hypochlorite (chlorine bleach) for washing out root canals?
 - k Yes
 - k No No further questions
 3. Can you tell me the type of bleach you use in root canals?
 - k Milton
 - k Johnson's Antibacterial Solution
 - k Domestic Bleach from the bottle (please write the brand name) _____
 - k Domestic Bleach weakened to: . . . %
 - OR: [. parts bleach parts water] with: (choice below)
 - k Demineralized or distilled water k Tap water
 - k Tank water
 4. Where is your bleach normally stored prior to use?
 - k Cupboard k Drawer
 - k Bench k Open shelf
 - k Other (describe) _____
 5. What sort of container is the bleach stored in for at least 24 hours prior to use?
 - k Original container k Opaque glass bottle
 - k Open container k Plastic syringe
 - k Glass syringe k Clear plastic
 - k Other (describe) _____
- Dental Attendant's Name

Fig 1. Blank questionnaire to assess endodontic practice and sodium hypochlorite use.

practices, a single response was duplicated for other members of the group where the respondent indicated that the product used and procedures followed were identical for all members of the group. If not the same, then details were collected for each individual specialist.

An initial approach to the selected practices was made by telephone. As most of the questions involved established surgery procedures, staff in the practice were questioned first. Non-technical wording was deliberately used on the survey form for this reason. Recourse was made to the practitioner only if clarification was required. When the initial response was negative, but where the initial approach indicated that follow-up would be fruitful, additional calls were made to the practice. Facsimile or postal follow-up was used when requested by the practice personnel. Individual dentists and endodontists were telephoned personally where earlier approaches had not produced a response.

The practitioners surveyed were chosen from the Australian Dental Association's Dental Directory 1999.¹² All specialist endodontists classified under the Australian Dental Association's numerical practice codes 14, 24 and 34 were surveyed. This gave a total of 63 endodontists, one of whom was found to have retired. A proportional stratified random sample of 200 general dental practitioners was chosen from the above directory. All 6224 practitioners with the numerical practice code 01 (private general practice) were numbered consecutively for each State or Territory.

Following this, a proportional number of practitioners was then allocated to each State or Territory by dividing the total number of general practitioners in each State by 31.12 (equivalent to multiplying by the sampling fraction – 200/6224), and rounding to the nearest whole number. A random number generator was then used to produce a random selection of the required size within each State/Territory group, with the numbers allocated in the first step above used to identify each practitioner. Total numbers of dentists in each State and Territory and the number surveyed are shown in Table 1.

For both the endodontists and general dentists, the survey responses to each question were summarized and expressed as relevant proportions. For the general dentists, the overall proportions were calculated as weighted sums of proportions from each State or Territory appropriate to the stratified design. These 'stratified percentages' differ slightly from simple percentages. A 95 per cent confidence interval for a proportion¹³ was also calculated for the percentage of general dentists using sodium hypochlorite. Such an interval was not calculated for the endodontists, since the survey sampled the entire population and therefore all results relating to this group can be considered as the true or population values.

Comparisons between the general practitioners and endodontists were made with a one-sample proportion test¹³ using the relevant population value of the endodontists in the null hypothesis.

Table 1. Number of general dentists per state/territory and number of dentists surveyed, with percentage who used sodium hypochlorite for endodontic irrigation

State	Number of general dentists	Number of dentists surveyed	% in state used NaOCl
ACT	118	4	*
NSW	2166	70	66.15
NT	31	1	*
QLD	1023	33	65.63
SA	614	19	89.47
TAS	94	3	*
VIC	1561	50	88.89
WA	617	20	76.47
Totals	6224	200	

*Sample size too small for percentage to be significant

RESULTS

Responses were obtained from all 62 endodontists. Of the 200 general practitioners surveyed, only 11 did not respond, giving a response rate of 94.5 per cent for this group. Of the 189 general dentists who responded, 185 (97.88 per cent) provided endodontic treatment procedures in their practices.

Use of sodium hypochlorite

Use of sodium hypochlorite solutions for endodontic irrigation was considerably greater among the endodontists than general dentists, with 58 (93.5 per cent) of the endodontists using sodium hypochlorite for irrigation, compared with 138 (74.49 per cent) of the general dentists who undertook endodontic treatment. Using a one-sample proportion test, this difference was found to be statistically significant ($P < 0.001$).

It should be noted that, on a State and Territory basis, the percentages of general practitioner respondents to the survey who used sodium hypochlorite for endodontic irrigation did vary and these data are shown in Table 1. A chi-squared test of association,¹³ omitting Tasmania, Australian Capital Territory and Northern Territory figures, demonstrated a significant difference in numbers of practitioners using sodium hypochlorite by State ($P < 0.05$). The use of a stratified random sample by State, rather than a simple random sample, was therefore important, as the result from the latter method would have relied heavily on the relative numbers sampled in each State. Data for Tasmania and the two Territories were too small for significant conclusions to be drawn. The following analyses of sodium hypochlorite use are expressed as

Table 2. Choice of nominated domestic bleach by practitioner type

Domestic bleach brands	General dentists	Endodontists	Totals
Budget bleach	1		1
Claxton Pacific Liquid Bleach		1	1
Coles		1	1
Homebrand	1		1
No Frills	1	5	6
Scotts		1	1
SnoWhite	1		1
Western County Household Bleach		1	1
White King	6	9	15
Zixio	1	2	3
Total	11	20	31

percentages of those practitioners who did use sodium hypochlorite, rather than of the total number of respondents or the total number surveyed and are detailed in Table 2 and 3, and Fig 2 and 3.

Type of sodium hypochlorite

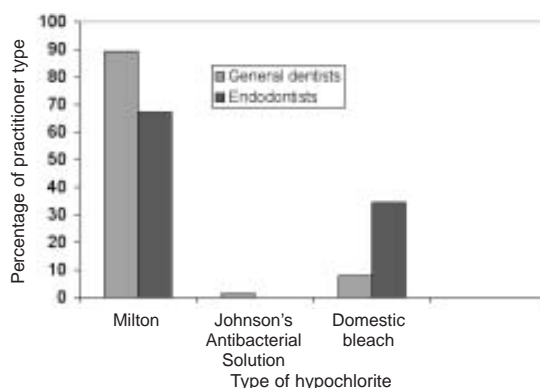
The most common type of sodium hypochlorite used in endodontic practice by both general practitioners and endodontists was Milton. This brand was chosen by 89.42 per cent of general practitioners compared with only 67.24 per cent of endodontists, with the difference in proportions being statistically significant ($P < 0.001$). White King (13.79 per cent) was the most popular brand of domestic bleach used by endodontists. Two general dentists used Johnson's Antibacterial Solution, which is another infant sanitizer. All remaining general dentists used some form of domestic bleach, with White King again the most commonly used (3.76 per cent), although the use of this brand was confined to the State of Victoria. Figure 2 compares the type of sodium hypochlorite used by general dentists and endodontists as a percentage of the responding practitioners who used sodium hypochlorite. A breakdown of domestic bleach choice by brand name and practitioner type for the 31 practitioners who chose to use sodium hypochlorite in this form is also illustrated in Table 2. It should be noted that one specialist endodontist use both Milton and a domestic bleach.

Method of storage

An overwhelming majority of practitioners stored their sodium hypochlorite in a cupboard (Fig 3) away

Table 3. Breakdown of type of hypochlorite used and final concentration by practitioner type

Irrigant concentration (% available chlorine)		4.50%	4.00%	2.50%	2.00%	1.50%	1.00%	0.50%	0.33%	Totals
General dentists	Milton						120	1	1	122
	Johnson's Antibacterial Solution					2				2
	Domestic Bleach	1	4		2	2	1			10
	Totals	1	4	0	2	4	121	1	1	134
Endodontists	Milton						38			38
	Domestic Bleach	1	6	1	3		5			16
	Totals	1	6	1	3	0	43	0	0	54
Combined totals		2	10	1	5	4	164	1	1	188



NB: One endodontist used both Milton and domestic bleach

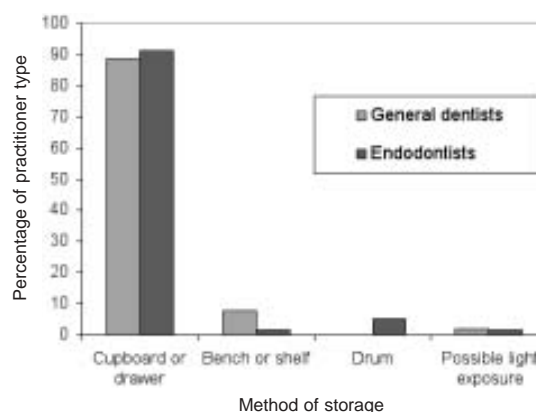
Fig 2. Comparison of hypochlorite choice by practitioner type.

from light, with 89.66 per cent of endodontists and 84.56 per cent of general practitioners using this location. The second most common choice was a drum for endodontists (5.17 per cent) and an open shelf for general practitioners (5 per cent). A solitary general practitioner stored sodium hypochlorite in the refrigerator. The most popular storage container used was the original container, with 53.45 per cent of endodontists and 65.93 per cent of general practitioners retaining this packaging. Plastic syringes were chosen by 19.68 per cent of general practitioners for storage of all types of sodium hypochlorite compared with on 12.06 per cent of the specialists, the difference being statistically significant ($P < 0.05$). Seven of the 39 specialists (17.95 per cent) who used Milton, stored it in a plastic syringe, and 24 of the 125 general dentists (19.20 per cent) using Milton also stored it in a plastic or glass syringe.

When the combination of storage place and container is considered, only the following combinations of storage parameters showed any risk of light exposure and subsequent lowering of chlorine concentration. Two general practitioners kept syringes of sodium hypochlorite on an open shelf; one general practitioner stored sodium hypochlorite in a clear plastic container on an open shelf; and one specialist used plastic syringes stored on an open shelf. Thus, there were four instances of potential deterioration from exposure to light amongst all the responses to the survey. No respondents stored their sodium hypochlorite in open containers.

Final concentration of irrigant

Four respondents (one general dentist and three endodontists) nominated a brand of domestic bleach for which the authors were unable to determine the concentration of available chlorine. For these four respondents it was not possible to calculate a final concentration of sodium hypochlorite used. One endodontist used both Milton and domestic bleach, but dilution data were not provided for the domestic



NB: Some practitioners checked more than one method of storage. Totals equal more than 100 per cent

Fig 3. Comparison of storage methods for hypochlorite by practitioner type.

bleach. These five responses were eliminated from data for the final concentrations used. Of the remaining 188 responses for which final concentrations could be calculated, 134 were from general practitioners and 54 from endodontists and these data are detailed in Table 3.

A 1 per cent w/v solution was the most common final concentration used by both specialists and general dentists. A greater percentage of endodontists used concentrations above 1 per cent w/v compared with the general practitioners, this difference in percentages being statistically significant ($P < 0.001$). A full breakdown of final concentration of sodium hypochlorite used by type of practitioner and type of sodium hypochlorite chosen is shown in Table 3.

Type of water for dilution

Five general practitioners and 10 endodontists diluted their sodium hypochlorite before use. Four of the general practitioners and eight endodontists used demineralized water for this purpose. One general dentist and two specialists used tap water. No practitioners used rain water for dilution. Milton was the parent solution for three of the general dentists diluting their sodium hypochlorite, but all other practitioners who diluted the purchased product were using domestic bleach of some type.

Regional distribution of type of sodium hypochlorite and mode of use

Among endodontists, the No Frills brand of domestic bleach was more popular in New South Wales, (five out of the 21 respondents) whereas none of the endodontists in other States chose this brand. For the general practitioners, the White King brand was more popular in Victoria (six out of 40 respondents) whereas none of the general practitioners in other States chose this brand. Otherwise, there did not appear to be any major regional differences, according to State, for any of the other results.

DISCUSSION

Choice of practitioners surveyed

Not all States of Australia have a separate registration category for endodontists, so the approach taken of identifying endodontists by Australian Dental Association practice codes was chosen. The relatively small number of specialist endodontists in Australia meant that there were no great difficulties in including all specialists in the survey.

An overwhelming majority of Australian dentists belong to the Australian Dental Association, with the Federal Secretariat of the Association estimating that greater than 90 per cent of practicing dentists are members. The sample size of 200 general practitioners, representing 3.21 per cent of the Directory total, combined with the small number of questions made a telephone survey practicable.

Quality of response to survey

In general, similar surveys of dentists' work patterns¹⁴ require a great many postal follow-ups to obtain a 75 per cent response rate. In the conduct of this survey, a combination of telephone contact, the small number of questions used and the strategy of targeting practice staff for the routine questions, probably contributed to the high response rate. The overall response to the survey (95.8 per cent) added validity to the survey results, re-inforcing the findings of Evans,¹⁵ who argued for small samples with a high response rate. Given the high response rate to this survey by general dentists, and the claim that over 90 per cent of practicing dentists belong to this organization, it can be confidently predicted that the results of this survey fairly represent general dentists in Australia. Through the use of stratified random sampling by State, that is selecting samples randomly within each State or Territory rather than within the whole of Australia, a more precise overall estimate and State-by-State comparison of hypochlorite usage was obtained. However, it should be noted that there were only four general practitioners sampled in the Australian Capital Territory; three in Tasmania and one general practitioner sampled in the Northern Territory, so that generalizations relating to general practitioners in these three regions would be uncertain. The 100 per cent response from specialist endodontists means that the use of sodium hypochlorite reported in this paper is directly representative of all Australian endodontists.

Traditionally, surveys such as this are directed at dental practitioners themselves. While it could be argued that the practice staff might not be as aware as the dentist of the brand of sodium hypochlorite purchased or dilutions used, this was not reflected in the responses. At least one practitioner when telephoned had no knowledge of either the brand or dilution of sodium hypochlorite used. Further, it appears unlikely that practitioners would personally perform the purchase of either infant sanitizer or domestic bleach. Dilution of sodium hypochlorite

would also likely be performed by ancillary staff, although it is conceded that this might be performed by a practitioner immediately prior to use. Additionally, part of the survey protocol was recourse to the practice principal where there was any doubt on the part of the staff member.

Dentists performing endodontics

Brennan *et al.* showed an almost 50 per cent increase in the provision of endodontic services in Australia over a 10-year period,¹⁶ but no study has reported the proportion of dentists who perform endodontics. The finding that nearly 98 per cent of general dentists surveyed undertook some endodontic treatment in their practices was not unexpected, as even practitioners who generally choose not to perform endodontic treatment, would occasionally be compelled to do so for pain relief.

Sodium hypochlorite use and regional distribution

Of great interest is the fact that only three quarters of the general dentists used sodium hypochlorite for irrigation during endodontic treatment. While this is a high proportion of those practitioners, it is well below the near 94 per cent figure for endodontists. It would seem that endodontists have great confidence in the properties of sodium hypochlorite for endodontic irrigation and that this confidence does not appear to be shared by their general practitioner colleagues. Two possible reasons may be that any reluctance to use rubber dam by general dentists would allow sodium hypochlorite, which has a very unpleasant taste, to escape into the mouth and so bring a strong reaction from patients, perhaps discouraging its further use, and that there may be an over-emphasis on the risks of forcing sodium hypochlorite through the apex into the surrounding periapical tissues. It has been proposed that this occurrence can be avoided by ensuring that the syringe needle does not bind in the canal, by avoiding forceful injection and perhaps by using specialized needles with a rounded tip and a side-located orifice.¹⁷

The large interstate variations in sodium hypochlorite use by general dentists were not expected. Nearly 90 per cent of general dental practitioners in South Australia and Victoria used sodium hypochlorite as an irrigant while in New South Wales and Queensland some two thirds of general practitioners used sodium hypochlorite for endodontic irrigation. General dentists in Western Australia fell between these two broad groups, with approximately three quarters of the respondents indicating that they use sodium hypochlorite for irrigation. It can be surmised that the influence of individual academic/specialist staff on both undergraduate students and at continuing professional education levels in the various State universities could be significant enough to cause such variation.

Type of sodium hypochlorite and regional distribution

General dentists (89.42 per cent) were far more likely to use Milton than were endodontists (67.24 per cent).

The use of Milton may have been taught to undergraduates in some dental school, and this proven and safe practice with a potentially tissue-toxic material could have persisted. A further possibility is the notable use of 'Milton' as a generic term for sodium hypochlorite, which may have influenced the practitioners' choice of irrigant. In addition, it is possible that some specialists may use domestic bleach because of its lower cost. This survey indicated that White King is the most popular brand of domestic bleach used by endodontists and also by general dentists in Victoria. The findings that the White King brand had its use restricted to Victoria and the No Frills brand restricted to New South Wales, are possibly a function of the commercial penetration of particular manufacturers and/or retailers, rather than any perceived superiority of the product. In the case of the White King brand, it is possible the sodium hypochlorite choice of endodontists in particular regions might be seen by general dentists as a tacit endorsement of that product.

Method of storage

From the point of view of potential deterioration in concentration of available chlorine, the storage place and type of container chosen by both endodontists and general practitioners was generally satisfactory, with only four instances of a potential risk of undue loss of therapeutic activity due to inappropriate storage conditions.

The finding that a smaller percentage of endodontists (12.06 per cent) stored all forms of sodium hypochlorite in syringes prior to use compared with general dentists (19.68 per cent) was unexpected, although similar percentages of specialists (17.94 per cent) and general dentists (19.20 per cent) stored Milton in plastic or glass syringes. It has been demonstrated that storage of Milton in syringes with needles attached can cause rapid corrosion of the needle, probably due to the salt content of Milton.¹¹ It is suggested that, where Milton is the chosen irrigant, this practice should be restricted to syringes for immediate use if there is a needle attached, although syringes with a plastic cap should present no such risk. The presence or absence of a needle on the syringe was not addressed in this survey.

Final concentration of irrigant

Of the practitioners who used sodium hypochlorite for irrigation, the overwhelming majority chose a final concentration of 1 per cent w/v. Eleven endodontists (20.37 per cent) and nine general dentists (6.76 per cent) used domestic bleach, and of these, 68.75 per cent of the specialists and 90 per cent of the general practitioners used a concentration greater than 1 per cent w/v. From these high proportions, the principal reason for purchasing domestic bleach may be to obtain a higher concentration of sodium hypochlorite in the final irrigant, rather than to economize on the

cost. It is also notable that when looking at all respondents to the survey who used sodium hypochlorite, the specialists (20.37 per cent) were over three times more likely than general dentists (5.61 per cent) to use their sodium hypochlorite at a concentration greater than 1 per cent w/v, perhaps to obtain a more thorough therapeutic effect or a shorter treatment time.

Type of water for dilution

The choice of water type for dilution of sodium hypochlorite is an important consideration as reticulated water supplies typically contain a wide range of inorganic salts and their metallic ions. These can act as a catalyst to accelerate the break down of sodium hypochlorite, which reduces its shelf-life and produces precipitates of unknown composition.¹¹ Additionally, tank water can contain both organic material (from leaves and animal droppings) and inorganic products (from roof sheeting, guttering and from the tanks themselves). Both organic material and metallic ions accelerate the loss of active chlorine content in sodium hypochlorite solutions.⁸ A small number of practitioners (three) used tap water for dilution, and the remainder used demineralized or distilled water.

CONCLUSION

This study confirms that almost all general dental practitioners undertake some endodontic procedures. The assumption that sodium hypochlorite is used widely by these practitioners as an endodontic irrigant has been confirmed by this study. However, its use is more prevalent among endodontists than general practitioners. Endodontists are also more likely to use sodium hypochlorite in the form of domestic bleach than their general practitioner colleagues and at higher concentrations than general dentists although a 1 per cent w/v solution is the most common choice for both groups. While there were no clinically significant regional differences in sodium hypochlorite choice, storage or dispensing by those who use this material, the choice of sodium hypochlorite as an endodontic irrigant by general dentists was more common in Victoria and South Australia than in other States.

Both endodontists and general dentists generally used appropriate methods for the storage, handling and dilution of sodium hypochlorite from the point of view of minimizing its loss of available chlorine content with time.

It is suggested that the survey format used here of a telephone approach to ancillary staff with a limited number of questions targeting their areas of knowledge or information access can improve the typically poor response rates for surveys of clinical practice.

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