Knowledge and Practices of Family and Emergency Physicians in Managing Non-traumatic Dental Conditions: a Case-based Survey

by

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A thesis submitted in conformity with the requirements for the degree of Master of Science
Graduate Department of Dentistry
University of Toronto

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2017

Abstract

**Background:** Physicians are often patients’ first point of contact for management of non-traumatic dental conditions (NTDCs). **Objective:** To evaluate the knowledge and practices of Ontario physicians in managing NTDCs. **Methods:** A scenario-based online survey was distributed to Ontario family and emergency physicians (n = 1012). Descriptive and logistic regression analyses were performed. **Results:** 204 surveys were completed (20.2% response rate). A majority of the sampled physicians would prescribe antibiotics for NTDC scenarios in which an antibiotic would not be indicated. Antibiotic overprescribing was significantly associated with practicing in smaller communities and with patient pressures. About half of the sample (52.9%) felt discomfort in overall management of NTDCs, while 85.3% felt that their training inadequately prepared them to manage NTDCs. **Conclusions:** Ontario physicians report NTDC management practices that are not in line with “best evidence” care. Areas that present opportunities for improvement in the physician management of NTDCs have been identified.
Acknowledgments

This dissertation is the conclusion of research that has been carried out from 2014 to 2016 in fulfilment of a Masters of Science degree in the Graduate Department of Dentistry, University of Toronto, Canada. This thesis has been made possible with the help and support of many people, to whom I would now like to express my sincere gratitude.

First and foremost, I would like to thank my thesis supervisor, Dr. Amir Azarpazhooh, for his expert guidance every step of the way in this research project. He provided me with direction and encouragement from day one, and this research would not have been possible without his unconditional support.

I would also like to express my gratitude to my advisory committee members: Dr. Cal Torneck, Dr. Karl Iglar, and Dr. Carlos Quinonez. Their counsel and input over the last two years have been invaluable to this project. In particular, Dr. Torneck, your willingness to lend support at every turn was deeply appreciated.

To my colleagues in the Graduate Endodontics program, thank you for creating a stimulating and fun environment in which to learn and grow. I would like to express my gratitude to my endodontic co-residents, particularly Dr. Annie Shrestha and Dr. Nghia Huynh, for their friendship, advice, and encouragement.

To my parents, Jackie and Isaac, and my sister Judy and brother Eric, thank you for your endless support and encouragement throughout the duration of my studies. I would also like to acknowledge my family and friends who continue to inspire me to work hard and to reach my full potential.

I further extend my appreciation to the funders of this project: the Canadian Academy of Endodontics Endowment Fund and the Alpha Omega Foundation of Canada.

Dr. Ralph Dana – Toronto, Canada, October 2016
# Table of Contents

Acknowledgments .................................................................................................................. iii

Table of Contents .................................................................................................................... iv

List of Tables .......................................................................................................................... vii

List of Figures ........................................................................................................................ ix

List of Appendices .................................................................................................................. x

1 Introduction .......................................................................................................................... 1
   1.1 The importance of appropriate management of dental emergencies by physicians ... 1
   1.2 Physician knowledge and practices in treating non-traumatic dental conditions ...... 2
   1.3 Overprescription of antibiotics .................................................................................. 2
   1.4 Antibiotic resistance ................................................................................................. 2
   1.5 Summary statements ................................................................................................. 3
   1.6 Rationale for this study ............................................................................................. 4
   1.7 Conceptual framework for this study ....................................................................... 5
   1.8 Objectives of this study ........................................................................................... 5
   1.9 Research questions .................................................................................................. 6
   1.10 Supplements to Chapter 1, Tables and Figures ......................................................... 7

2 Literature Review .................................................................................................................. 8
   2.1 Background: Physicians and NTDCs ...................................................................... 8
       2.1.1 Prevalence ....................................................................................................... 8
       2.1.2 Barriers to care .............................................................................................. 10
       2.1.3 Knowledge and practices of physicians in treating dental emergencies .......... 11
   2.2 Etiology, presentation and management, and diagnosis of common NTDCs .......... 12
       2.2.1 Pulpal disease and bacteria .......................................................................... 12
       2.2.2 Common NTDCs and their management ...................................................... 14
       2.2.3 Diagnosing NTDCs ....................................................................................... 17
   2.3 Antibiotics: use in endodontics ............................................................................... 19
       2.3.1 Indications for antibiotics ............................................................................. 20
       2.3.2 When antibiotics are unnecessary ................................................................. 21
       2.3.3 Additional considerations for physicians ...................................................... 23
       2.3.4 Antibiotics and endodontic pain ................................................................... 24
2.4 Antibiotics: characteristics, dosing, duration, and selection ........................................... 24
   2.4.1 Antibiotic characteristics and dosing ................................................................. 24
   2.4.2 Antibiotic duration ............................................................................................... 29
   2.4.3 Antibiotic selection ............................................................................................. 31
2.5 Antibiotics: side effects and antimicrobial resistance ....................................................... 32
   2.5.1 Side effects ........................................................................................................... 32
   2.5.2 Antimicrobial resistance ..................................................................................... 33
2.6 Antibiotics: overprescribing ............................................................................................. 36
   2.6.1 Dentists ................................................................................................................ 36
   2.6.2 Physicians ............................................................................................................ 37
   2.6.3 Inappropriate prescribing: Why does it happen? ............................................... 38
   2.6.4 Non-biomedical factors ....................................................................................... 39
2.7 Supplements to Chapter 2, Tables and Figures ............................................................... 42

3 Materials and Methods ........................................................................................................ 63
   3.1 Study design ............................................................................................................. 63
   3.2 Study sample ........................................................................................................... 63
   3.3 Survey implementation ............................................................................................. 63
   3.4 Survey instrument ................................................................................................... 64
   3.5 Statistical considerations ......................................................................................... 66
      3.5.1 Sample size calculation ...................................................................................... 66
      3.5.2 Data analysis ...................................................................................................... 66
   3.6 Supplements to Chapter 3, Tables and Figures ......................................................... 69

4 Results ................................................................................................................................... 72
   4.1 Descriptive results .................................................................................................. 72
      4.1.1 Response rate .................................................................................................... 72
      4.1.2 Practice and demographic characteristics ..................................................... 72
      4.1.3 Clinical scenario results .................................................................................... 73
      4.1.4 Comfort, and practices in managing NTDCs .................................................. 75
      4.1.5 Knowledge acquisition ..................................................................................... 76
      4.1.6 Non-biomedical factors .................................................................................... 76
      4.1.7 Overprescribing Index (OPI) and Narcotic Prescribing Index (NPI) ............... 77
   4.2 Bivariate and multivariate analyses .......................................................................... 77
      4.2.1 Overprescribing Index (OPI) ........................................................................... 77
5 Discussion ......................................................................................................................................... 95
  5.1 Management of NTDC scenarios ................................................................................................. 95
     5.1.1 Antibiotics ............................................................................................................................ 95
     5.1.2 Analgesics .............................................................................................................................. 97
  5.2 Comfort and practices in managing NTDCs .............................................................................. 98
     5.2.1 Comfort levels ....................................................................................................................... 98
     5.2.2 Use of flowcharts / guidelines ............................................................................................ 99
     5.2.3 Interprofessional relationships ............................................................................................ 99
  5.3 Knowledge acquisition .............................................................................................................. 99
  5.4 Practice pressures .................................................................................................................... 100
  5.5 Summary of findings ................................................................................................................. 101
  5.6 Limitations of this study ........................................................................................................... 102
     5.6.1 Cross-sectional research ...................................................................................................... 102
     5.6.2 Response rate, nonresponse error, and sampling frame .................................................... 103
     5.6.3 Survey instrument ................................................................................................................ 106
  5.7 Strengths of this study .............................................................................................................. 107
  5.8 Interim management of patients with NTDCs: approaches for physicians ......................... 108
     5.8.1 Analgesics ............................................................................................................................ 108
     5.8.2 Intra-oral local anaesthesia .................................................................................................. 109
     5.8.3 Intra-oral local administration of methylprednisone ........................................................ 109
     5.8.4 Delayed prescriptions of antibiotics .................................................................................. 110
  5.9 Applicability of this study’s findings and future directions .................................................... 110
     5.9.1 Supplementing physician knowledge regarding NTDCs ................................................. 111
     5.9.2 Improving practice habits: interventional approaches ...................................................... 112

References ........................................................................................................................................ 117

Appendices ...................................................................................................................................... 134
List of Tables

Table 1. Prevalence and characteristics of dental emergencies facing medical practitioners...... 42
Table 2. Physician knowledge and training in treating traumatic dental injuries (TDIs). ........... 46
Table 3. Physician dental knowledge and training, and exposure to NTDCs............................ 48
Table 4. Summary of presentations and management of IP, AAA, CAA. .............................. 50
Table 5. Sample dental history questionnaire for physicians. ........................................... 51
Table 6. "Red flags" associated with NTDCs. ....................................................................... 52
Table 7. Indications for adjunctive antibiotic use as recommended by the AAE................ 53
Table 8. Antibiotic dosing regimens as recommended by the AAE ................................. 54
Table 9. Antibiotic prescribing by dentists for NTDCs....................................................... 55
Table 10. Canadian medical associations who were contact and unable to issue our survey due to Canadian anti-spam legislation ................................................................. 69
Table 11. Study participant inclusion and exclusion criteria .............................................. 70
Table 12. Variables regressed against (i) high OPI, (ii) high NPI, and (iii) discomfort in overall NTDC management ................................................................. 71
Table 13. Practice and demographic characteristics of the sample................................ 82
Table 14. Comparison of characteristics of the study participants with National Physician Survey results for Ontario family physicians ......................................................... 83
Table 15. Management of NTDC clinical scenarios......................................................... 84
Table 16. Drug preference among physicians when electing to prescribe an antibiotic and/or analgesic in scenarios 1-4. ................................................................. 85
Table 17. Signs and symptoms—when treating an NTDC—for which an antibiotic is indicated.

Table 18. Practitioner self-reported comfort and practices in managing NTDCs.

Table 19. Sources of education and training regarding NTDCs.

Table 20. Perceived influences of "practice pressures".

Table 21. Overprescribing Index (OPI) and Narcotic Prescribing Index (NPI).

Table 22. Univariate logistic regression analysis of predictors for (i) high OPI, (ii) high NPI, and (iii) discomfort in overall management of NTDCs.

Table 23. Summary of multivariate logistic regression analysis -- significant predictors for (i) high OPI, (ii) high NPI, and (iii) discomfort in overall management of NTDCs.
List of Figures

Figure 1. Conceptual framework of the decision to prescribe an antibiotic. ........................................ 7

Figure 2. Survey response rate. ........................................................................................................ 81
List of Appendices

Appendix A. Survey instrument. ................................................................. 134

Appendix B. Flowchart: sign/symptom-based approach for NTDCs. .................. 161
1 Introduction

1.1 The importance of appropriate management of dental emergencies by physicians

A 2013 Canadian survey indicated that 6.1% of the respondents had been treated at a hospital emergency department (ED) for a non-traumatic dental condition (NTDC). A NTDC is defined as a dental condition not related to trauma that results in facial, odontogenic, and jaw pain, and/or the signs and symptoms of dental infection. A 2011 report by Quiñonez estimated that each year 5.4% of patients seeking care at Canadian hospital emergency clinics do so for these reasons. If the trend of patients seeking medical care for NTDCs parallels those seen in US hospitals, there is a strong likelihood the number of patients attending Canadian hospital EDs for NTDCs will increase in the coming years. Patient visits to physicians for oral health-related complaints are not limited to hospital emergency department settings, as patients may often seek care in physicians’ offices for similar reasons—a trend that was shown in a recent retrospective secondary data analysis of health system utilization in Ontario. Over an 11-year fiscal period from 2001-2011, visits to Ontario physicians for oral-health related diagnoses totalled approximately 208,375 visits per year, with an average of 1,298/100,000 persons. Furthermore, a survey study of low-income patients in the United States who had experienced a toothache in the preceding 12 months found that 20.1% of the sample had contacted a physician’s office for interim relief. While the vast majority of patients with NTDCs do still seek care in a dental facility, it is apparent—for a variety of reasons—that many patients do not, making medical practitioners their first point of contact for advice and management of the dental problem. Aside from unnecessarily adding to the cost and burden of patient care at hospital EDs and physician practices, the treatment of NTDCs in a medical facility places the onus of care on health practitioners who may not be equipped, trained, or fully aware of changing trends in their management. This highlights a need to ensure that all those who provide care for patients with NTDCs are familiar with the current standard of care required in the management of these types of emergencies.
1.2 Physician knowledge and practices in treating non-traumatic dental conditions

The published literature assessing the knowledge and practices of medical practitioners that treat patients with NTDCs is limited. There are strong indications that the teaching of oral and dental disease-related emergencies in most medical schools and residency programs is limited.\textsuperscript{1,14,21-26} This was reflected in papers published by Skapetis et al. in 2012\textsuperscript{21} and Mansour and Cox in 2006.\textsuperscript{19} Mansour and Cox attributed a poor understanding and hence the poor management of dental emergencies by physicians to a number of reasons including (1) minimal dental education in medical school, (2) inconsistent exposure to dental problems, (3) absence of management guidelines for dental emergencies, (4) diagnostic difficulties associated with the poor localisation of dento-facial pain, and (5) poor communication and collaboration between general medical and dental practitioners.\textsuperscript{19}

1.3 Overprescription of antibiotics

Inflammation associated with infection is the most common cause of pain and swelling in the orofacial region. While there is a need to treat some patients experiencing these symptoms with antibiotics, recent reports have indicated that for the vast majority of these patients an antibiotic is not required.\textsuperscript{27-36} This however is not reflected in surveys, which highlight a high prescription rate for antibiotics by physicians who treat NTDCs.\textsuperscript{15,16,21,37} A study that examined US hospital data from 1997 to 2007, for example, showed a rise of 20\% (from 47 to 67\%) in medically treated patients receiving antibiotics for NTDCs over an 11 year period.\textsuperscript{38} While this was a noteworthy study in demonstrating the increase in antibiotic use in the management of NTDCs in a hospital environment, the study did not delineate the dental conditions treated; consequently, it was not possible to determine whether the use of the prescribed antibiotics was appropriate or not. The literature on this topic is discussed in depth in Chapter 2.

1.4 Antibiotic resistance

According to the published information, rising rates of bacterial resistance to antibiotics is a concern in Canada\textsuperscript{39-41} and globally.\textsuperscript{41-53} The global rise in bacterial resistance to antibiotics has made the management of once manageable infections difficult—if not impossible, extended the complexity of treatment and the length of stay of patients that require hospital care, and
increased the financial burden of health services for once easily and inexpensively managed infections. This is particularly true in countries where the health care system is publically supported. The indiscriminate use of antibiotics by physicians has been cited as the principle contributor to the rise and spread of antibiotic-resistant infections. It is apparent from the published literature that overprescribing of antibiotics by physicians is occurring within several areas of medicine in Canada and globally. Overprescribing of antibiotics has also been cited as being responsible for an increased incidence of allergic reactions—some of which may be fatal, drug toxicity, and an increased incidence of unfavourable interactions with other drugs taken by patients. Furthermore, since antibiotics only address symptoms of NTDCs and not the cause, the use of an antibiotic in the treatment of this type of emergency, even when necessary, often provides the patient with only temporary relief unless definitive dental care is also undertaken. By addressing only symptoms and not the cause, recurrent symptoms and recurrent visits by patients are often necessary, adding further to the cost of medical services in a government supported system.

Treatment of NTDCs, like all patient care, should be balanced between the need to address the patient’s primary complaint and their exposure to undesirable side effects of the treatment undertaken. While this is true of any drug prescribed by a healthcare provider, it is especially true of antibiotics. Within the medical profession, various factors are hypothesized to lead to overprescription of antimicrobials by a practitioner, including (1) an inadequacy of the physician’s knowledge and management of patients with infectious disease, (2) the expectations and demands of patients, (3) a physician’s sincere desire to provide what is felt to be the “best treatment” regardless of side effects and costs, (4) a failure to consider alternative treatments, (5) an inappropriate use of diagnostic laboratory studies, (6) a fear of medico-legal reprimand, (7) a belief that newer broad-spectrum antibiotics are the most effective form of treatment, and (8) the pressures a physician experiences in running a busy medical practice (i.e. time and economic pressures).

1.5 Summary statements

- Patients with NTDCs may be seen by physicians in hospital emergency departments and in physician office environments.
- Little data exist regarding physicians’ knowledge and practices in treating NTDCs.
• Overprescribing of antibiotics by physicians is occurring within several areas of medicine in Canada and globally, and there are data indicating that physicians may also overprescribe antibiotics when treating NTDCs.
• The prevalence of antibiotic resistant bacteria is on the rise globally, and indiscriminate use of antibiotics is the main factor in its emergence and dissemination.
• Reasons for the overprescription of antibiotics by physicians may be multi-factorial.

1.6 Rationale for this study

Physicians faced with patients requiring treatment for an NTDC should be able to assess the cause of the patient’s symptoms and provide the patient with “best evidence” care until a visit with a dentist can be scheduled. When this is not done, there is a strong possibility that the patient may receive inappropriate treatment, especially the unnecessary administration of an antibiotic. This adds to the global rise in antibiotic-resistant infections and the accompanying health-related and economic-related result that ensues.

At present, little information is available regarding the knowledge and practices of Ontario physicians that manage patients with NTDCs or their reason for and pattern in antibiotic use when patients present with those symptoms. This study is being undertaken to obtain this information, the reasons for the type of treatment rendered, and to make suggestions for remedial intervention to correct unsupported practices, if it is found to be prevalent. Such suggestions would be of interest to medical regulatory bodies—i.e. College of Physicians and Surgeons of Ontario, Royal College of Physicians and Surgeons of Canada, College of Family Physicians of Canada, Canadian Association of Emergency Physicians—with the intent of altering the current practices used by physicians for the management of patients with NTDCs. A need to incorporate additional dental knowledge into medical school curricula may be identified. Our results may have relevance throughout North America because of the comparability between Canadian and American medical education, as reflected in the Liaison Committee on Medical Education (LCME)’s accreditation standards for Canadian and American undergraduate and post-graduate medical programs.

The above interventions could help in the context of rising antibiotic-resistant infections if they result in a more judicious use of antibiotics. Studies show that significant changes in prescribing habits may reduce the rate at which new antimicrobial resistance accumulates. Reducing
antibiotic prescribing at the general practice level results in a reduced incidence of resistance in the local community, demonstrating that modification in prescribing habits of individual practitioners can influence the patterns of resistance. A report by Conly, published in the CMAJ in 2002, added further support to this possibility by stating that there was an adjusted decline of 11% in total antibiotic prescriptions (21% in beta-lactamase related prescriptions) in Canada between 1995 and 2000, on the heels of a national consensus conference on the unnecessary prescribing of antibiotics held in 1997. These results show that systematic efforts to reduce unnecessary prescribing can have an impact.

1.7 Conceptual framework for this study

The conceptual framework (Figure 1) of this study is based on an amalgamation of related frameworks present in other papers (Zimmerman et al. and Sumpradit et al.), augmented by information derived from factors that influence physician prescribing practices published in papers by Conly, Cadieux et al., and Lam and Lam. Our conceptual framework relates physician prescribing practices to an interplay between (1) the condition presented by the patient, (2) the physician’s demographic characteristics (i.e. age, gender, and years since graduation), (3) the physician’s knowledge, attitude, and comfort in treating patients with NTDCs, (4) the source of the physician’s knowledge, (5) the effect of regulatory bodies (i.e. through published guidelines and addenda to the medical training curriculum), and (6) the nature of medical practice (i.e. practice or patient pressures). Our framework is also structured to include factors related to public health care policies and regulations. Overall, the conceptual framework contains variables that can be expanded and defined in a number of ways so as to be directly measured using a survey instrument, which will be discussed in Chapter 3.

1.8 Objectives of this study

The primary objective of this study is to evaluate the knowledge and practices of Ontario family and emergency physicians with regard to treating NTDCs, with specific focus on antibiotic usage. Our study’s secondary objective is to identify possible characteristics or factors which may be associated with undesirable prescribing behaviours.
1.9 Research questions

1) What are the knowledge and practices of Ontario family and emergency physicians when managing patients with NTDCs?

2) Are there specific factors that predispose a physician to prescribe an unnecessary antibiotic when treating an NTDC?
1.10 Supplements to Chapter 1, Tables and Figures

Figure 1. Conceptual framework of the decision to prescribe an antibiotic.
2 Literature Review

2.1 Background: Physicians and NTDCs

2.1.1 Prevalence

A significant number of patients seek treatment of a dental emergency from a medical practitioner who is either in family practice or associated with a hospital emergency department (ED). Common dental presentations facing physicians and ED personnel include dental pain, dental infections, oral and maxillofacial trauma, and post-dental treatment related complications such as secondary haemorrhage after oral surgery or a dry socket. Pain is generally cited as the number one reason for seeking emergency dental treatment; up to 66% of patients seeking emergency dental care do so for the purpose of pain relief. Over the next 6 months, predictions are that 12% of the US population will experience a toothache. Dental pain can have detrimental effects on an individual’s quality of life and social functioning and thus acts as a strong motivator for patients to seek emergency care. This type of dental emergency is referred to as a non-traumatic dental condition (NTDC) and is part of a group of emergencies generated by infectious and non-infectious conditions of the dental and facial tissues not related to trauma. This research focuses on NTDCs (rather than traumatic dental injuries, or TDIs), as most dental-related ED visits are for non-traumatic presentations (i.e. caries and infections).

Table 1 summarizes several key articles in the literature that assess the prevalence and characteristics of dental emergencies seen by medical practitioners, with a specific emphasis on Canadian and American studies.

Canada

Each year, a significant number of patients with dental emergencies are seen in Canadian hospital emergency departments (EDs). Many patients also seek similar care from their family physician. A survey of Canadians in taken in 2013 reported that 6.1% of the sampled population had visited a hospital emergency facility for an NTDC in the past. Quiñonez has also estimated that NTDCs account for approximately 5.4% of all ED visits in Canada. When extrapolated to include the entire Canadian population 15 years of age and older, it indicates that there are approximately 1.5 million ED visits by a Canadian for an NTDC in a given year.
Periapical abscesses and toothaches appear to account for 56% of these dental-related ED visits.\textsuperscript{17} In 2014, in Ontario alone, there were approximately 61,000 patient visits to hospital emergency departments for oral health problems\textsuperscript{84}, this means that every 9 minutes a patient is visiting an ED in Ontario because of dental pain (Ontario Health Health Alliance, personal communication, 2015). From 2003-2006, there were 141,365 ED visits for NTDCs in Ontario.\textsuperscript{17} From 2001-2011, there were approximately 208,375 Ontario Health Insurance Plan (OHIP) approved billing claims per year for visits to physicians for oral health-related diagnoses, with an average of 1,298/100,000 persons.\textsuperscript{10}

**United States**

US studies have shown that annually 1 to 4.3% of all ED visits are dentally related,\textsuperscript{3-5} and that this number is on the rise.\textsuperscript{6-9,85} Demographics of ED visits for dental-related conditions in the US indicate that the population making these visits is principally uninsured, a minority, and of low socioeconomic status.\textsuperscript{3,18,86} Ladrillo et al. reported that 70% of the dental emergencies in a US ED were caused by caries and dentoalveolar abscesses.\textsuperscript{83}

In a 2014 study, Allareddy et al. reported that dental-related issues accounted for 4,049,361 ED visits over a three year period, with a mean hospital ED charge per visit of $760 USD and total ED charges across the entire United States during the three year study period of $2.7 billion USD.\textsuperscript{3} A more comprehensive study reported by Wall and Nasseh in 2013 showed that the number of dental ED visits in the US increased from 1.1 million in 2000 (1.1% of total ED visits) to 2.1 million in 2010 (1.7% of total ED visits).\textsuperscript{6} They concluded that dentally-related visits to EDs is on the rise as an absolute number, as an increase in per-capita visits, and as an increase in the percentage of all ED visits.\textsuperscript{6}

**Elsewhere**

An Australian study by Verma and Chambers published in 2014 reported that 0.9% of all ED visits were dentally-related; of these, 66% were dental abscesses and toothaches.\textsuperscript{12} A study of 30 family medical practices in Wales reported that 0.3% of patients in a one-year span were patients with dental problems.\textsuperscript{20} These patients were three times more likely to seek treatment on weekends than were patients attending for other reasons (presumably due to a lack of dental
services available at these times). Skapetis et al., in their review article which examined the prevalence of NTDCs presenting at EDs reported in the literature, concluded that dental emergencies constitute an estimated 1 to 3.8% of all ED visits globally.

Summary

While the number of dental-related emergencies seen by physicians is not high when calculated as a percentage of all ED visits, when extrapolated to an absolute number, it indicates that millions of patients seek relief for an NTDC from a medical practitioner each year in North America and globally. Unless those who treat these emergencies have a good understanding of the underlying causes for the symptoms that prompt the visit and the “best evidence” approach to their treatment, a potential exists for the overuse of antibiotics and the attending health and economic risks they impose. As this is of global concern and has an impact on the health care systems of all nations including Canada, it seems reasonable to suggest a current assessment of prescribing habits by physicians who treat NTDCs be undertaken.

2.1.2 Barriers to care

Most patients seek care from their family dentist when a dental emergency arises. Others, for a variety of reasons, will seek such care from an ED or a family physician (Table 1). The inability to access a dentist at the time of the emergency has been cited in a survey by Cohen et al. as the most common reason for making that choice. Other reasons why patients may seek care with a physician rather than a dentist include: lack of appropriate insurance, availability of free medical care as opposed to fee-for-service dental care (particularly in Canada), perceived severity of complaint, and lack of knowledge among some immigrant populations regarding the physician-dentist distinction.

As a result of these barriers to care, medical practitioners often act as the first point of contact for advice and management in cases of NTDCs. Consequently, it is important that emergency and family physicians who encounter these patients possess appropriate knowledge in treating these presentations.

In the next section, we look at the current state of the knowledge and practices of physicians asked to treat a dental emergency.
2.1.3 Knowledge and practices of physicians in treating dental emergencies

The available literature on the topic of physicians treating NTDCs is scarce; however, unlike NTDCs, the knowledge and practices of physicians regarding treatment of traumatic dental injuries (TDIs) has been well-studied. The consensus is that knowledge regarding management of TDIs is at best inadequate among physicians. Table 2 highlights several key articles regarding physician knowledge vis-à-vis TDIs. This may act as a marker that knowledge among physicians regarding the management of NTDCs may be even poorer still.

While there is little information regarding physician knowledge with respect to NTDCs, there is some literature available indicating that there is likely limited training in diagnosis and management of oral disease and dental emergencies in medical school curricula. Table 3 provides a summary of the data available regarding physician training and knowledge regarding general dental health, oral presentations and NTDCs. Overall, it is apparent that there is insufficient information to assess whether the medical management of NTDCs is appropriate.

There is then a question as to what kind of treatment may be provided by physicians when presented with NTDCs. Mansour and Cox are of the belief that physicians may not be well equipped to manage dental pain for several reasons: (1) minimal dental education in medical school, (2) inconsistent exposure to dental problems, (3) absence of management guidelines, (4) poor localisation of dentofacial pain, and (5) poor communication and collaboration between general medical practitioners and dentists. Furthermore, because physicians generally do not have the training to perform definitive dental treatment procedures (i.e. extractions, incision and drainages, or pulpal extirpations), their management of NTDCs is only palliative and largely pharmacologically based (i.e. prescribing of analgesics and/or antibiotics).

To illustrate this, two studies reported that only a minority of ED visits for dental complaints resulted in a procedure being undertaken; in the majority of instances, analgesics and antibiotics were prescribed, and patients were referred to another clinic for follow-up care. In a third study, 90% of dentally-related ED visits did not result in local dental care, with most patients receiving prescription medications. A similar pattern was noted in a fourth study, where a majority of patients who sought treatment for a dental emergency at an ED received only a prescription for medication and no other treatment. However, it appears that most
physicians do appropriately issue a referral to a dentist for follow-up care after initial assessment.\textsuperscript{16,17}

Considering that seeing a dentist is required in order to receive definitive care, this may indicate a need to better educate patients that visiting EDs or family physicians for NTDCs should generally be avoided and reserved for certain severe circumstances (the vast majority of NTDC-related visits to EDs are considered non-urgent\textsuperscript{69}), as definitive treatment is generally not rendered.

Of course, this does not change the fact that there are and will continue to be millions of patients visiting EDs and family physicians for NTDCs today and in the future (Table 1); accordingly, the level of physician knowledge and training in treating patients presenting to them with NTDCs should not be ignored.

Because physician treatment of NTDCs is generally limited to pharmacologic management, it is important that they understand the presenting conditions and the rationale behind the pharmacological intervention they are prescribing, if any. The following section discusses the pathophysiology of pulpal and periapical disease (and the role of bacteria), and then discusses several common non-traumatic dental conditions which physicians are likely to face. This will be followed by a description of what may be considered appropriate management when these conditions are addressed.

2.2 Etiology, presentation and management, and diagnosis of common NTDCs

2.2.1 Pulpal disease and bacteria

When discussing the management of NTDCs, it is important to understand the role bacteria play in the development of pulpal disease. The oral cavity is a complex bio-ecosystem, populated by planktonic bacteria and bacterial communities called biofilms.\textsuperscript{99} Biofilms contain numerous microbial species, subspecies, and clones that group together to colonize a surface in the oral cavity. Biofilm development is influenced by factors such as environment, virulence potential, pH, oxygen, and the availability of nutrients.\textsuperscript{99} Pathogenic shifts in virulence are thought to be linked to the development of oral disease\textsuperscript{99} and therefore is an important consideration when establishing a protocol for the treatment of a dental infection.\textsuperscript{100} Endodontic infections occur
when opportunistic bacteria gain access to the dental pulp and then to the apical tissues. Endodontic infections are generally polymicrobial and diverse, predominantly composed of anaerobic and facultative gram positive coci and gram negative rods, and filamentous forms.

Tooth vitality is determined by the health of the dental pulp. The pulp is the soft tissue occupying the centre of the tooth, consisting of vasculature, neural tissue, and immune cells, embedded in a connective tissue core. A vital pulp responds to hot, cold, and electrical stimuli. The dental pulp is surrounded by a permeable calcified hard tissue, dentin, which is in turn surrounded by cementum and enamel. The calcified tissues normally provide strong mechanical support and protection. As long as these hard tissues remain intact, the pulp remains protected from the adverse conditions present in the oral cavity. Pulp injury typically occurs when the hard tissue barrier is compromised and bacterial exposure is present. Typical of this is exposure to oral bacterial products, and direct bacterial invasion of the pulp that occurs with caries, or subsequent to hard tissue loss associated with trauma and restorative procedures. Non-microbial injury such as interference with blood flow to the pulp caused by trauma, thermal insult (i.e. overheating during restorative procedures), or chemical insult (i.e. undesirable reactions to chemical agents used during restorative procedures) may also occur and leave the pulp vulnerable to microbial invasion over time. Irreversible pulpitis is a clinical diagnosis of pulp injury assigned to teeth when it is felt the pulp has exceeded its ability to repair regardless of treatment. When related to the presence of bacteria it is often but not exclusively associated with the presence of symptoms. Pulp infection, in turn, may lead to apical periodontitis (an inflammatory lesion of the apical tissues) as bacteria or bacterial products interact with apical tissue at radicular sites where vasculature channels transverse the dental irritants.

Because bacteria play a critical role in endodontic disease, it may seem reasonable at face value for practitioners to prescribe antibiotics in treating pulp disease; however, as will be shown in the following sections, the use of antibiotics in most cases is inappropriate and provides no added benefit.
2.2.2 Common NTDCs and their management

In this section, several of the more common presenting non-traumatic dental conditions are discussed, including their presentation and treatment.

2.2.2.1 Irreversible pulpitis (IP)

**Condition**

Irreversible pulpitis is an immune inflammatory pulp response that compromises the pulp beyond its ability to repair.\(^{109}\) Irreversible pulpitis can arise as a result of caries, a cracked tooth, or trauma.\(^{112}\) It can be accompanied by history of severe spontaneous recurring pain, and exaggerated pain to cold or hot which appears to linger after the stimulus is removed.\(^{112}\) The pain often radiates and is poorly localized. Clinically, a the tooth will often respond abnormally to cold and electric pulp testing, while remaining normal to percussion and palpation testing (in most typical presentations).\(^{112}\) Radiographic examination is often negative save for the possibility of identifying a possible etiological factor.\(^{112}\)

**Management**

Relief of pain is generally gained through pulpal extirpation or tooth extraction. Accordingly, there is little a physician can do for these patients other than to prescribe an analgesic and refer the patient to a dentist.\(^{113,114}\) In terms of palliative care by the physician, prescription of NSAIDs are usually best, but the physician should evaluate the patient and the level of pain to determine the choice and dose of analgesic required.\(^{73}\) If the physician has appropriate training, local intra-oral anaesthesia may be administered to control the pain. The physician must keep in mind that irreversible pulpitis is a localized inflammatory response of the pulpal tissues rather than a general infective process and therefore is not influenced by the administration of an antibiotic. Several studies have clearly shown that antibiotic administration is of no benefit in such cases and should be avoided.\(^{115-118}\)

2.2.2.2 Acute apical abscess (AAA)

**Condition**

An AAA is a highly symptomatic inflammatory response of the periapical connective tissues,
which starts when an infection of the necrotic pulp initiates an inflammation of the apical tissues that in turn becomes populated with virulent opportunistic microorganisms from the infected root canal. Infection of the apical tissue with virulent microorganisms (represented by a high proportion of Gram negative anaerobic types) evokes a robust polymorphonuclear response leading to the formation of pus that characterizes this condition. The focal accumulation of pus in the apical tissue leads to the clinical symptoms that accompany AAA such as slight elevation in the socket and localized pain and swelling. Orofacial infections typically have a rapid onset. Pain can be both spontaneous and initiated by percussion of the infected tooth or palpation of the tissue overlying the root apex. Swelling may be mild or severe, indurated or fluctuant, and localized or generalized. Teeth that become abscessed usually harbour a totally necrotic pulp and therefore fail to respond to cold and electrical stimuli and manifest a loss of apical bone in the radiograph. Resorption of the overlying cortical bone and localization of the pus beneath the alveolar mucosa can lead to a swelling that is palpable and fluctuant. The source of pain is usually easy to determine, as the affected tooth becomes increasingly tender to percussion and chewing and may be somewhat extruded from the socket. Pus present in the apical tissue can in some instances spread along fascial planes to extend to other anatomical sites where they establish a space abscess remote from but anatomically related to the abscessed tooth. Spread of pus around the muscles of mastication can lead to trismus and pain and difficulty in opening of the mouth. Bacterial metabolites, endotoxins, exotoxins and host inflammatory biomarkers may enter the bloodstream and give rise to an increase in body temperature (pyrexia) and malaise. If left untreated, bacteria in the bloodstream may result in a septicaemia, leading to an inflammatory response, leucocytosis, potential organ damage and even death.

Management

Because AAA is caused by a localized accumulation of bacteria and pus, the recommended treatment is a decompression of the abscessed site. This can be accomplished directly through incision and drainage of the abscess or indirectly through the infected root canal by ensuring that the pathway from apex to the opening in the tooth crown is free of necrotic pulpal debris. When possible, tooth extraction may accomplish the same ends. Typically, AAAs are of short duration (2 to 7 days or less) if the cause is eliminated. Matthews et al. in a systematic review of the literature concluded that, “in the management of localized acute apical abscess in
the permanent dentition, the abscess should be drained through a pulpectomy or incision and drainage.”\textsuperscript{119} They indicated that antibiotics provide no additional benefit in the otherwise healthy patient.\textsuperscript{119} This was further corroborated by Cope et al. who concluded that there was insufficient evidence to recommend the use of antibiotics for patients with an abscessed tooth and no systemic involvement.\textsuperscript{122} In the event of systemic complications (e.g. fever, malaise, diffuse swelling, lymphadenopathy, gross facial swelling, eye closure, dysphagia, tachycardia, rigors or cellulitis), or for an immunocompromised patient, antibiotics are indicated in addition to drainage of the abscess.\textsuperscript{28,30,31,35,100,119,122}

It should be appreciated that antibiotics cannot reach and eliminate microorganisms in the root canal system at an adequate therapeutic concentration when the pulp is necrotic.\textsuperscript{123} As such, the source of the problem (i.e. bacterial colonization of the necrotic pulp) is unaffected by systemic antibiotic therapy.\textsuperscript{123} Accordingly, the patient will always need definitive dental treatment in order to eliminate the pathologic etiology.

With regard to physician management of a localized acute apical abscess, as in cases of irreversible pulpitis, there is often little the physician can do for a patient other than pharmacologic management of the symptoms (unless the physician is well-versed in intra-oral incision and drainage procedures, which may provide temporary relief for the patient). Prescribing analgesics is common, but the prescribing of antibiotics for a localized acute apical abscess when there is no systemic involvement is considered unnecessary; rather, antibiotics should only be prescribed when there are signs of systemic involvement.\textsuperscript{29,124} Because it is unlikely that most physicians have appropriate training for intra-oral incision and drainage procedures,\textsuperscript{21} it would not be surprising if many physicians consider prescribing an antibiotic for localized swellings even when no systemic involvement is detected, despite the inappropriateness of this practice. A grey area may present itself when the patient is unable to see a dentist for definitive treatment over a prolonged time period (i.e. longer than a few days), with the fear of impending development of systemic involvement.\textsuperscript{73} However, it should not be forgotten that antibiotic therapy is generally only indicated when there is systemic involvement, and, as such, the most appropriate management in the majority of cases would be to prescribe an analgesic and to refer the patient to a dentist for definitive treatment as soon as possible.
2.2.2.3 Chronic apical abscess (CAA)

**Condition**

CAA originates from an AAA associated with an infected necrotic pulp that discharges spontaneously via a sinus tract to a mucosal or cutaneous (less commonly) surface either intermittently or continuously. The point of discharge may either approximate the infected tooth or be remote to it, depending upon the surrounding anatomical structures. While basically an asymptomatic condition, there have been instances where patients have complained of some discomfort just prior to an episode of discharge. Radiographs when available will demonstrate a loss of bone about the apical area of the infected tooth. Because the pain that attends this condition is either mild or non-existent, presentation to the physician generally relates to the presence of a “gum boil” or parulis in the oral cavity or a “dermal boil” when drainage is extra-oral. Intra-oral discharge may result in the patient complaining of a bad or sour taste. “Dermal boils” pose a significant challenge in diagnosis because of the many dermal conditions a draining sinus can mimic. More often than not, the radiograph becomes the critical diagnostic tool.

**Management**

Because the etiology of this presentation is a necrotic and infected pulp, endodontic treatment or tooth extraction is required; accordingly, this will require referral to a dentist. Again, it must be remembered that the microorganisms responsible for the abscess originate from the infected pulp space devoid of a functioning vasculature, and thus antibiotics would prove to be ineffective and therefore are contraindicated for this condition. Similarly, in instances where the sinus drains derrmally, local treatment—either surgical or non-surgical—is likewise ineffective. Because the patient is usually not experiencing pain, analgesics are generally not required. Referral to a dentist by the physician is the best course of action.

Table 4 summarizes the above presenting conditions (IP, AAA, CAA) and their management.

2.2.3 Diagnosing NTDCs

Understanding the pathophysiology and clinical presentation of the preceding dental conditions will greatly assist physicians in establishing a working diagnosis and in understanding what
palliative care is most appropriate—if any—until the patient is seen by a dentist. Physicians should aim to understand the different causes of orofacial pain, both odontogenic and non-odontogenic, before addressing an oral complaint (discussion of non-pulpal aetiologies of dental pain are beyond the scope of this paper). Despite the number of orofacial conditions in which pain is a symptom, it is generally accepted that 56% to 70% of dental complaints seen by a physician will be pulpal-related in origin. The majority of the non-pulpal conditions are traumatic in origin making it uncommon for physicians to be presented with dental emergencies of periodontal or non-odontogenic origin.

A dental history questionnaire, along with a clinical exam, may be used by physicians in helping to establish a diagnosis. Because the vast majority of dental presentations do not require an antibiotic, it is important to identify the etiology of the dental pain and prescribe an antibiotic only when indicated (i.e. in cases where systemic involvement is apparent). For example, as discussed above, understanding the presenting signs and symptoms of irreversible pulpitis (i.e. prolonged pain from cold, air, heat; possible spontaneous pain), which is an inflammatory condition of the pulpal tissues, will allow the clinician to understand that its interim palliative treatment would best consist of anti-inflammatory analgesics.

A sample of questions that may be asked during a dental history is presented in Table 5. This table has been adapted and modified from ones suggested by Rodriguez and Sarlani and Kingon. The physician should keep in mind that not all questions need to be asked (unless deemed relevant) and that the verbal history provided by the patient needs to be considered in combination with the clinical exam (i.e. assessment of swellings, tooth mobility, possible presence of large carious lesions, pain on palpation of the soft tissues or percussion of the teeth, possible presence of other soft/hard tissue abnormalities, non-healing extraction sockets, etc.) to form a working diagnosis. Additional questions may need to be asked if it appears that the pain is not of pulpal origin (i.e. periodontal pain, TMJ pain, maxillary sinusitis, pericoronitis, and other non-odontogenic pain). These conditions are not as frequently seen by physicians and thus are beyond the scope of this paper. The more information gathered by the clinician during the patient interview and clinical exam, the greater the chance of formulating an accurate working diagnosis.
Physicians must also be able to identify any “red flags” and signs of dental-related problems that are potentially life threatening and require hospitalization.73 During the clinical exam, physicians should attempt to identify the source of the problem and assess whether there is a cellulitis or circumscribed abscess, or other signs and symptoms that are precursors of a serious sequelae. If any of these signs are present, the physician should understand the need for antibiotics and should consider whether hospital admission is appropriate (in more extreme cases).73 Table 6 lists signs and symptoms that physicians should look upon as “red flags.”

If a decision to prescribe an antibiotic is made, antibiotic selection and dosing recommended in the American Association of Endodontists (AAE) guidelines (discussed in section 2.4) should be considered.29

In cases where a physician prescribes an antibiotic for NTDC, this treatment choice, if effective at all, provides only temporary relief, since it does not in itself resolve the underlying dental problem.12,17 Ultimately a referral to a dentist is required for definitive treatment and thus must be emphasized by the treating physician. Without definitive treatment, repeat visits can result and add further costs to the healthcare system (this may be the case if a patient’s symptoms temporarily resolve following antibiotic use, thus neglecting definitive treatment).11,12,14,16,69,70,126,127 This was supported by Figueiredo et al.’s study128 and by Verma and Chambers’ study, in which 5.7% of patients presented to an ED multiple times within the study period, suggesting that a subset of patients were not seeking definitive treatment following short-term pharmacologic relief.12

With a basic understanding of the above NTDCs and their management, we next turn our attention to the specificities regarding antibiotics, starting with their uses in pulpal and periapical disease.

2.3 Antibiotics: use in endodontics

The prudent practitioner must understand that antibiotics are not required for the vast majority of endodontic conditions.27,36 As described in the preceding section, the use of antibiotics in treating endodontic disease is limited at best. Longman et al. evaluated a series of published clinical trials regarding the use of antibiotics in endodontics and concluded that antibiotics are not routinely indicated in the practice of endodontics.35 The definitive treatment of an acute
apical abscess is drainage and removal of the cause of the infection, and for most patients this is the only treatment required. Drainage may be achieved by accessing and clearing the root canal to establish a pathway for drainage, tooth extraction, and/or incision of the soft tissues overlying the abscess. Drainage of the abscess allows for the release of pus, reduction of the number of microorganisms, decrease in tissue pH, and increased oxygen diffusion. With these local measures, the use of antibiotics is not necessary in the vast majority of cases.

### 2.3.1 Indications for antibiotics

Indications for adjunctive antibiotics as defined by the American Association of Endodontists’ (AAE) clinical practice guidelines are found in Table 7. It should be noted the indications in Table 7 are consistent with signs and/or symptoms indicating systemic involvement, or what has been designated as a “red flag” in Table 6.

The AAE guidelines state that prophylactic antibiotics for immunocompromised patients (i.e. AIDS, cancer, autoimmune disease, corticosteroid therapy, uncontrolled diabetes, etc.) is controversial. Patients with AIDS should not receive routine prophylaxis, as the opportunistic pathogens common to AIDS are not susceptible to routine prophylactic antibiotic use. This practice can result in the development of antibiotic-resistant microbes and, consequently, serious superinfections. On the other hand, dental patients presenting with an impaired host defence (i.e. chemotherapy, organ transplant or tissue graft recipient, insulin-dependent diabetes, and alcoholics) or patients with indwelling catheters may benefit from antibiotic prophylaxis if their white blood cell count is below 2500 (normal = 4000-11000). This, however, is still a point of controversy.

The AAE also points out that prescribing prophylactic antibiotics for those with prosthetic joint replacement is also contentious. This position was also supported by the American Dental Association (ADA).

In accordance with AAE guidelines, the only established indication for antibiotic prophylaxis in dentistry is in the reduction of the potential consequences of a dental-related bacteraemia in a specific small group of at-risk patients. In 2007, the AHA issued guidelines regarding the prevention of infective endocarditis in medically-at-risk patients. The guidelines were revised at that time because the risk of an antibiotic-associated adverse event was found to exceed the
benefit (if any) gained from the prophylactic effect of the antibiotic. The 2007 guidelines restricted the use of prophylactic antibiotics to the following cardiac situations:

- Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
- Previous infective endocarditis
- Congenital heart disease (CHD)
  - Unrepaired cyanotic CHD, including palliative shunts and conduits
  - Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first six months after the procedure
  - Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
- Cardiac transplantation recipients who develop cardiac valvulopathy

The AHA has recommended that prophylactic antibiotic use be restricted to at-risk patients who undergo a dental procedure that involves manipulation of the gingival tissues and/or the periapical region of a tooth and for procedures that perforate the oral mucosa. This includes procedures such as suture removal, biopsies, placement of orthodontic bands, and intraligamentary and intraosseous local anaesthetic injections. The prudent practitioner should consider prophylactic antibiotic coverage for these at-risk patients during endodontic therapy as well.

### 2.3.2 When antibiotics are unnecessary

Antibiotics are not warranted for any of the following conditions, unless they accompany any one of the aforementioned indications (Tables 6, 7):

- Pain
- Edema
- Redness or heat
- Purulence
- Localized abscess
- Draining sinus tract

Pallasch lists several areas where antibiotic misuse occurs in dentistry. Several of these are
relevant to NTDCs:

(1) postsurgical prevention of an infection not likely to occur and not demonstrated clinically to respond to “after the fact” prophylaxis

(2) use in endodotics as analgesics

(3) failure to adhere to principles established for use of prophylactic antibiotics

(4) overuse to prevent metastatic “focal” infections

(5) treatment of chronic adult periodontitis, which is almost totally amenable to mechanical therapy

(6) using antibiotics instead of mechanical periodontal therapy

(7) chronic long-term antibiotic therapy for periodontal disease

(8) antibiotic therapy instead of appropriate incision and drainage

(9) use of antibiotics to prevent negligence claims

(10) antibiotics used in inappropriate situations, dosages, and durations of therapy

Prophylactic antibiotics have also been suggested in other areas of dentistry for a number of situations in order to reduce the likelihood of postoperative complications such as infection or alveolar osteitis (“dry socket”), but there is little support for this practice.\textsuperscript{131-133}

With regard to endodontic situations, there is an abundance of literature that supports the statement that antibiotics are rarely needed. Examples of these are:

- Antibiotics do not help resolve localized acute apical abscesses.\textsuperscript{134}
- Antibiotics do not help alleviate postoperative endodontic pain and swelling in symptomatic necrotic teeth.\textsuperscript{135}
- Antibiotics do not prophylactically prevent postoperative endodontic pain in asymptomatic necrotic teeth.\textsuperscript{136}
- Antibiotics do not reduce the rate of flare-ups in asymptomatic, necrotic teeth.\textsuperscript{137,138}
- Antibiotic use does not affect the radiological healing of teeth with chronic apical periodontitis.\textsuperscript{136,137}
- Antibiotic use does not prevent post-treatment infections in non-immunocompromised patients.\textsuperscript{104,131}
- Antibiotic use is of no benefit in alleviating pain from irreversible pulpitis.\textsuperscript{115,118,139}
Some clinicians argue that prophylactic antibiotics should be administered for medico-legal purposes, to protect against a lawsuit in case there is an adverse occurrence to the procedure undertaken. However, Walton and Chiappinelli\textsuperscript{136} argue that dentists who prescribe in non-beneficial situations and place a patient at risk for other complications may face legal action if the patient experiences a severe adverse reaction to the antibiotic (discussed more in section 2.5.1). Walton and Chiappinelli\textsuperscript{136} point out further that the practitioner should keep in mind that penicillin can cause an anaphylactic reaction that accounts for 400 to 800 patient deaths each year. At-risk patients cannot always be screened out by a health history, and thus most anaphylactic reactions occur in persons with no history of penicillin allergy.\textsuperscript{136}

Evidence-based medicine (and dentistry), defined as “the conscientious, explicit, and judicious use of current best evidence in making decisions about the care of individual patients,”\textsuperscript{140} is an important pillar in today’s clinical decision making by health care professionals. Use of clinical practice guidelines, such as those issued by the AAE and AHA above, constitute an important part of putting evidence-based medicine into clinical practice.

2.3.3 Additional considerations for physicians

It stands to reason that the prescribing of an antibiotic by a physician for a patient with a localized acute apical abscess without systemic involvement remains controversial. If the patient were to be seen by a dentist, local measures (i.e. pulpal extirpation or extraction) can be taken to establish drainage and effect relief of the symptoms. However, when a patient is seen by a physician, local measures are generally not possible. If the patient can be seen by a dentist shortly after consulting with a physician, local measures can be instituted and an antibiotic administration avoided. This is why good communication between health providers is important in patient care. In situations where the patient may be unable to see a dentist for an extended time period, then it is possible that some physicians may consider prescribing an antibiotic, despite this condition in itself not warranting this intervention. Clearly, individual circumstances must be considered on a case-by-case basis when physicians are making a decision to prescribe an antibiotic; however, in general, antibiotic prescribing should be avoided under the vast majority of circumstances, particularly in urban areas where dental health care professionals are readily accessible.
2.3.4 Antibiotics and endodontic pain

Endodontic pain results from an inflammatory process in which a variety of chemical mediators such as arachidonic acid metabolites, cytokines, chemokines, kinins, serotonin, and neuropeptides are present.\textsuperscript{141} These mediators induce sprouting of nociceptors in the pulp, periodontal ligament and periradicular bone, that later are activated to produce the symptoms of pain. The mediators also result in tissue edema that can increase local tissue pressure and increase the severity of the symptoms.\textsuperscript{141} Interventions should be aimed at reducing the inflammatory process in order to relieve pain.\textsuperscript{141} In understanding this pathophysiologic process, the clinician can better appreciate that antibiotics are not required to address the inflammatory process and thus are not indicated for relieving its accompanying pain.\textsuperscript{122,141,142} Clinical study results are consistent in making this statement.\textsuperscript{115,116,141}

NSAIDs, rather than antibiotics, are considered to be helpful in relieving such pain, as they target the inflammation present in the tissues.\textsuperscript{143} The effectiveness of NSAIDs in alleviating dental pain is well established and therefore are considered to be first line pharmacologic therapy.\textsuperscript{144,145} In cases of severe pain where NSAIDs are not expected to be sufficient to control acute pain, narcotic analgesics may be considered.\textsuperscript{146}

Next we look at antibiotics in greater depth with regard to their specific characteristics and recommended regimens.

2.4 Antibiotics: characteristics, dosing, duration, and selection

2.4.1 Antibiotic characteristics and dosing

Mechanisms of action of antibiotics include any of the following:\textsuperscript{45}

(1) inhibition of cell wall synthesis
(2) alteration in cell membrane permeability
(3) inhibition of ribosomal protein synthesis
(4) suppression of nucleic acid (DNA) synthesis
(5) inhibition of folic acid synthesis

Understanding the pharmacokinetics and pharmacodynamics of antibiotics is critical in properly prescribing them. Despite the large number of antibiotics available for use, there are only a
limited number that are appropriate in treating dental infections.\textsuperscript{100}

The choice of class of antibiotic is usually based on previously published susceptibility testing and clinical findings,\textsuperscript{101} but the selection of a particular type is generally done in an empirical manner.\textsuperscript{29,48,106} The AAE’s guidelines advise that narrow spectrum antibiotics should be the first chosen because broad-spectrum antibiotics produce more alterations to the normal gastrointestinal microbiota that can give rise to additional resistant organisms.\textsuperscript{29} Accordingly, AAE recommends penicillin VK as the first line therapy if an antibiotic is to be used.

\subsection*{2.4.1.1 Penicillin VK}

Penicillin V has often been the antibiotic of choice for endodontic infections because it is effective against many of the facultative and strict anaerobes commonly found in these infections, and it has a narrow spectrum and is inexpensive.\textsuperscript{34,101} \textsuperscript{29,147} After studying the susceptibility of bacteria isolated from acute periapical abscesses to the five most commonly used antibiotics in dentistry, Baumgartner and Xia\textsuperscript{101} concluded that penicillin V is the antibiotic of choice for endodontic infections “due to its effectiveness in polymicrobial infections, its narrow spectrum of activity (targeting mainly those found in endodontic infections), low toxicity and cost.” The penicillin antibiotic group is in fact considered by some to be the gold standard in the treatment of dentoalveolar infection.\textsuperscript{33} However, about 10\% of the population is allergic to penicillin VK and in those cases an alternate antibiotic needs to be selected.\textsuperscript{29} To achieve a steady therapeutic serum level with penicillin VK, it should be administered every 4-6 hours.\textsuperscript{29} Ideally, a loading dose of 1000 mg should be given, followed by 500 mg every 4-6 hours for 5-7 days.\textsuperscript{29} Following debridement of the root canal system and drainage of facial swellings, improvement in patient symptoms should be seen within 48-72 hours.\textsuperscript{29}

\subsection*{2.4.1.2 Amoxicillin}

Amoxicillin is an analogue of penicillin which is rapidly absorbed and has a longer half life.\textsuperscript{29} This is reflected in its higher and more sustained serum levels compared to penicillin VK. Amoxicillin costs only slightly more than penicillin VK.\textsuperscript{66} Due to the longer half-life and more sustained serum levels, amoxicillin is taken three times a day, increasing patient convenience.\textsuperscript{66} Usual dosage is a loading dose of 1000mg followed by 500 mg every 8 hours for 5-7 days.\textsuperscript{29} Amoxicillin may be used for serious odontogenic infections; however, its broad spectrum is generally more than is required for endodontic needs, and its use in a healthy individual may
contribute to the global antibiotic resistance problem. Some clinicians prefer amoxicillin over penicillin VK due to the more convenient dosing regimen for patients and possibly better patient compliance (three times daily vs. four times daily).

2.4.1.3 Amoxicillin with clavulanate

Amoxicillin with clavulanate has been shown to be the most effective antibiotic in endodontic pathogen susceptibility tests. Baumgartner and Xia showed that amoxicillin and amoxicillin with clavulanate have greater activity than penicillin VK for bacteria isolated from endodontic abscesses; however, they note that because amoxicillin and amoxicillin with clavulanate have a wider spectrum of activity than penicillin VK (which includes many species of bacteria found in other areas of the body), amoxicillin and amoxicillin with clavulanate may increase the risk of selecting for resistant organisms outside of the oral cavity. Baumgartner and Xia recommend penicillin VK as the drug of choice for periradicular abscesses, and that amoxicillin and amoxicillin/clavulanate be reserved for (i) the treatment of immunocompromised patients who may have odontogenic infections containing non-oral bacteria and (ii) for more serious infections due to their more rapid and sustained plasma levels. Clavulanate is a competitive inhibitor of beta lactamase, hence this combination has the ability to be effective against some penicillin-resistant bacterial strains. When used, the usual dose as recommended by the AAE is 1000 mg loading followed by 500 mg every 8 hours for 5-7 days.

2.4.1.4 Clindamycin

Clindamycin is effective against gram-positive facultative microorganisms and anaerobes. Baumgartner and Xia and the AAE both recommend clindamycin as the alternative of choice for patients allergic to penicillin or if a change in antibiotic is indicated. Patients who are allergic to penicillin would best be served with clindamycin, as it is active against many oral anaerobes and facultative bacteria and has the advantage of good bone penetration; however, it also has the potential to produce significant adverse side effects such as pseudomembranous colitis and neutropenia. Dosing, as recommended by the AAE, is a 600 mg loading dose followed by 300 mg every six hours for 5-7 days.

Though penicillin VK appears to be the most appropriate first line choice of antibiotic, there are those that choose clindamycin as their first choice of antibiotic in treating dental infections. Considering clindamycin’s low but serious risk of pseudomembranous colitis, broader spectrum,
and being four to five times more costly than penicillin, there does not seem to be a need to prescribe clindamycin as a first choice antibiotic.\textsuperscript{66} Penicillin is effective with less risk, less cost, and less contribution to antimicrobial resistance.\textsuperscript{66}

2.4.1.5 Metronidazole

Metronidazole is a synthetic antimicrobial which is bactericidal and active against anaerobes, but not against aerobes and facultative anaerobes.\textsuperscript{29} Metronidazole showed the greatest amount of bacterial resistance in Baumgartner and Xia’s study, and thus is not recommended as a first line antibiotic for endodontic infections.\textsuperscript{101} Metronidazole, however, may be used in combination with penicillin VK or clindamycin.\textsuperscript{29} If a patient’s symptoms worsen in the initial 48-72 hours after initial treatment and administration of penicillin VK or clindamycin, then metronidazole may be added as a supplemental medication to the original antibiotic.\textsuperscript{29} At this point though, it is crucial to first review whether diagnosis and treatment has been appropriate in managing the infection. The AAE recommended dosage is a 1000 mg loading dose followed by 500 mg dosing every six hours for 5-7 days.\textsuperscript{29}

Other dental infections in which anaerobic bacteria are implicated (such as pericoronitis, periodontal abscesses or acute necrotizing ulcerative gingivitis) are best treated with metronidazole.\textsuperscript{65}

2.4.1.6 Erythromycin

Erythromycin is a macrolide with a similar spectrum of activity to that of penicillin for gram-positive microorganisms.\textsuperscript{66} It has traditionally been prescribed to patients allergic to penicillin, but it is not effective against anaerobic bacteria (bacteria involved in primary dental infections).\textsuperscript{29} As a result, it is no longer recommended for treatment of endodontic infections. It also has a significant gastrointestinal upset capacity,\textsuperscript{29} and it inhibits the hepatic metabolism of numerous drugs, leading to a decrease in their clearance and resulting in an increased effect and/or toxicity.\textsuperscript{66} This interaction can occur with such drugs as carbamazepine, digoxin, theophylline, triazolam, and warfarin.\textsuperscript{66}

2.4.1.7 Azithromycin and clarithromycin

Azithromycin and clarithromycin are semisynthetic derivatives of erythromycin that have been modified to create a broader spectrum of antibacterial activity (including some anaerobes
involved in endodontic infections) and to improve tissue penetration. They have a longer elimination half-life resulting in decreased dosing schedules and a lower incidence of gastrointestinal distress and abdominal cramping than erythromycin. The AAE recommended dosing for azithromycin is a 500mg loading dose and 250 mg once a day for 5-7 days. The AAE recommended dosing for clarithromycin is a 500mg loading dose and 250mg every 12 hours for 5-7 days.

2.4.1.8 Other antibiotics

Doxycycline occasionally may be indicated if all the above are contraindicated, but it should be noted that many strains of bacteria show some resistance to tetracyclines. Cephalosporins are usually not used in the treatment of endodontic infections. Ciprofloxacin is a quinolone antibiotic that is not effective against anaerobic bacteria usually found in endodontic infections; however, with a persistent infection, it may be used if culture and sensitivity tests show bacteria susceptibility to ciprofloxacin.

In Dar-Odeh et al.’s review paper, the authors report that the most common antibiotic group used by general dentists throughout the world is the penicillin group, with the most popular being amoxicillin. This is followed in order by penicillin VK, metronidazole, and amoxicillin with clavulanate. Similarly, studies show that in the UK, the most prescribed antibiotics by dentists are amoxicillin, penicillin VK, and then metronidazole. In the United States, Yingling et al. found that endodontists most commonly prescribe penicillin VK as their first choice antibiotic (61.5% of respondents), and clindamycin is the second most commonly prescribed antibiotic with 29.6% of respondents using it as a first line choice.

2.4.1.9 Issues with antibiotic dosing

Previous guidelines published by the Commission of the Federation Dentaire Internationale (FDI) recommend that therapeutic antibiotics be given at a dose that will produce tissue concentrations higher than the MIC (minimum inhibitory concentration) for the bacteria implicated in the infection being treated. In practice, however, blood concentration of the administered antibiotic should exceed MIC by a factor of 4x to allow the antibiotic to penetrate tissue in sufficient concentration to have negative effects on the pathogens responsible for the infection. Pallasch describes the MIC eloquently: “The MIC is the lowest concentration of the antibiotic that prevents the growth of microorganisms after an 18- to 24-hour incubation.
period… Antibiotic resistance is defined as a rise in the microorganism MIC or reduced clinical efficacy of the antibiotic even to outright clinical failure of the antibiotic. The MIC breakpoint for resistance is the concentration of the antibiotic above which the organism is unaffected by the antibiotic. This breakpoint must be compatible with the blood levels of the antibiotic that can be reasonably attained with commonly used clinical doses.24,5

In 2012, the AAE recommended following Pallasch’s principles as follows:27,124,151

- The goal of antibiotic dosing is to achieve drug levels in the infected tissues which equal or exceed the MIC. Because serum levels of antibiotics do not necessarily reflect those in the infected tissues, we should aim for the antibiotic concentration in the blood to exceed MIC by 2-8x in order to ensure at least that a concentration approximating the MIC is achieved in the infected tissues.

- A loading dose should be used. This is usually best at 2x the maintenance dose. This helps achieve the goal of rapid, high blood levels in comparison to initiating therapy with the maintenance dose. Pallasch recommends use of a loading dose if the half-life of the antibiotic is longer than three hours or whenever a delay of 12 hours or more is unacceptable to achieve therapeutic blood levels. Most common antibiotics useful in dental infections have half-lives less than three hours, but the acute nature of orofacial infections requires therapeutic blood levels far sooner than 12 hours.121

- An oral antibiotic should be administered at dosing intervals of 3-4x its serum half-life, in order to achieve steady-state blood levels. The shorter the serum half life of the drug, the shorter the dosing interval will need to be in order to maintain continuous therapeutic blood levels of the drug.

Loading and maintenance doses recommended by the AAE in order to achieve the above recommended blood levels are compiled in Table 8. Yingling et al. found that a loading dose was used by 85.1% of endodontists in their survey.66

2.4.2 Antibiotic duration

Duration of the treatment should be sufficient to eliminate the pathogens.28,48 A 5-to-7 day course has been considered appropriate for most endodontic infections.66 There is support; however, for the idea that it is not necessary for patients to complete the full course of an antibiotic.65,152-154 It appears that a 2-to-3 day course (at doses recommended by the British
National Formulary) may be all that is needed in treating dentoalveolar infections rather than a traditional 5-to-7 day course.\textsuperscript{152,154} Lewis has stated that a 2-dose regimen of 3 g amoxicillin can achieve the same results as a 5 day course of treatment.\textsuperscript{153} A reduction in frequency of antibiotic intake has also shown favourable results in patient-oriented outcomes, such as increased convenience, improved compliance, and improved tolerability.\textsuperscript{154,155} In order to be effective, short-course antibiotic therapy requires that antibiotics have certain characteristics: bactericidal activity, rapid onset of action, easy penetrability into the tissues, activity against non-dividing bacteria, stability in adverse infection conditions such as low pH or presence of pus, a lack of propensity to induce resistance, and administration at an optimal dose and dosing regimen.\textsuperscript{156} They suggest that when the infection has resolved or is resolving, antibiotic use can be discontinued.\textsuperscript{121} This regimen is advantageous in that it may avoid selection of antibiotic resistant species, since this occurs most commonly after the use of lower doses of antibiotics over longer periods of time.\textsuperscript{65,100}

Pallasch\textsuperscript{45} states that there is a common misconception among dentists that patients should finish their course of antibiotics, every time, in order to avoid the development of resistant strains. Morrow and the AAE reinforce Pallasch’s position and agree that this is a common misconception among dentists.\textsuperscript{27} It has been commonplace for clinicians to prescribe antibiotics for 5 to 10 days and instruct the patient to finish the entire course of the antibiotic; however, it is more evident now than ever before that long courses of antibiotics are not needed.\textsuperscript{28,106} Pallasch explains that in certain situations, such as fungal infections, respiratory or urinary tract infections, where “rebound infections” are common, this practice is appropriate.\textsuperscript{45} Many practitioners wrongly misjudge how long an infection will last, and this leads to a longer duration of antibiotic therapy than is necessary; instead, antibiotics should be used aggressively and for the shortest time period that will prevent both clinical and microbiologic relapse.\textsuperscript{45,157} The best guide for the determining the duration of therapy is to clinically monitor the patient for improvement that indicates recession of the disease.\textsuperscript{27} Antibiotics may be discontinued safely after resolution of clinical symptoms of the infection and this usually occurs after two to three days of antibiotic treatment.\textsuperscript{28,106} Pallasch recommends that dentists are better off prescribing antibiotics for a course of 3 to 5 days with an adequate loading dose, following by a re-evaluation of the patient at which time additional antibiotic duration can be prescribed if indicated.\textsuperscript{45,157} This means that patients placed on antibiotics should be clinically evaluated on a
daily basis, and, when there is sufficient evidence of resolution of the infection, it is appropriate to terminate the antibiotic. The use of antibiotics in low doses and lengthy durations should be discouraged as it encourages the development and expression of microbial resistance. The AAE recommends adhering to Pallasch’s following principle: “Use an antimicrobial on an intensive basis with vigorous dosage for as short a period of time as the clinical situation permits.”

This concept of short duration, high dose antibiotic prescribing does not seem to be well accepted in dentistry at this point in time. For reference, a Canadian study found that the average duration for antibiotic prescriptions among general dentists is 6.92 days (range: 1 to 21 days). Yingling et al.’s survey of AAE members found that the average duration for antibiotic prescriptions is 7.58 days (range: 5 to 10 days). It has been shown that dentists in Kuwait and Jordan also prefer to prescribe antibiotics in lower dosages but over a longer period.

2.4.3 Antibiotic selection

Haas recommends that practitioners adhere to the following principles as guidelines in prescribing antibiotics:

- Use only when there is an indication.
- Use only when the risk/benefit balance is favourable.
- It is not a substitute for establishing adequate drainage.
- Choose the narrowest spectrum drug that will be effective.
- Prescribe an adequate dose.
- Prescribe for appropriate duration.
- Choose the drug with the fewest side effects.
- Choose the least expensive agent.
- Additional considerations:
  - Consider laboratory identification and sensitivity tests to target specific bacteria with antibiotics identified as effective.
  - Recognize that antibiotics encourage development of resistance if used for too long and/or at sub-optimal doses.
  - Consider alternatives to antibiotics such as topical debridement and application of topical antiseptics.
If a decision to prescribe an antibiotic is made, the AAE endorses the following antibiotic prescribing algorithm (appropriate dosing in Table 8):29,124

- Penicillin VK is the first choice of antibiotic (some may choose amoxicillin).
- If the patient is allergic to penicillins, clindamycin should be selected (if allergic to clindamycin, the clinician may give consideration to azithromycin).
- If after 2 to 3 days of using the initial antibiotic there is no improvement in the patient’s condition, the clinician may add metronidazole (if using a penicillin, the clinician may consider switching to clindamycin as well).
- If the patient fails to respond to the above in conjunction with local measures, consultation with an oral surgeon is advised.

It is apparent in the literature that there are wide variations among prescribing dentists in drug selection, dosing (frequency and amount), and duration of prescriptions.149,150 However, we should keep in mind that what is more important than deciding which antibiotic to use, at which dose and at what duration, is deciding whether an antibiotic is needed at all.27

Next, we look at the downside of antibiotics—particularly, their side effects and their association with antimicrobial resistance.

### 2.5 Antibiotics: side effects and antimicrobial resistance

Indiscriminate prescribing of antibiotics must be avoided; there are risks that must always be considered before prescribing an antibiotic, and the benefits must outweigh the risks.

#### 2.5.1 Side effects

Side effects of antibiotics may include the following:35,65-67

- Hypersensitivity reactions and drug fevers (associated with beta-lactam antibiotics)
- Pseudomembranous colitis (usually in conjunction with clindamycin)
- Nausea and vomiting
- Gastrointestinal distress (common with macrolides)
- Photosensitivity (common with tetracyclines)
- Renal toxicity (common with aminoglycosides)
- Drug interactions
• Selection and overgrowth of resistance microorganisms

Antibiotic-resistant microorganisms are of great concern and are discussed thoroughly in the following section.

2.5.2 Antimicrobial resistance

Antimicrobial resistance has increased significantly over the last 50 years. Literature supports that antibiotic resistance is on the rise in Canada. Furthermore, rising rates of antibiotic resistance are also of international concern. Antibiotic resistance leads to the continual need for newer and more costly antibiotics, raises hospitalization costs due to the need for special patient handling and infection prevention and control measures, and is a burden on society.

2.5.2.1 Prevalence of antimicrobial resistance

General

While not dentally-focused, WHO’s recent report on global antibiotic resistance shows that very high rates of resistance have been observed in all WHO regions in association with common bacteria (i.e. *Escherichia coli*, *Klebsiella pneumonia*, and *Staphylococcus aureus*) responsible for common health-care associated and community-acquired infections. WHO also reports that there are significant gaps in the proper surveillance of antibiotic resistance and a lack of standards for methodology, data sharing, and coordination regarding bacterial resistance. They conclude that, “despite the limitations of current surveillance, it is clear that antibiotic resistance has research alarming levels in many parts of the world.”

Many strains of *S. aureus* worldwide exhibit resistance to all medically important antibacterial drugs, with methicillin-resistant *Staphylococcus aureus* (MRSA) becoming one of the most frequent nosocomial pathogens. The prevalence of MRSA was less than 5% in most hospitals in the US and Europe in the early 1970s, but, by the 1980s, it increased to 40%. It was first reported in Canada in 1981. Canadian reports show that the proportion of methicillin resistant *S. aureus* isolates increased from 0.95/100 isolates in 1997 to 3.8/100 isolates in 1997, to 5.97/100 in 1999, and to 8.1/100 in 2000. The highest prevalence was in Ontario and British Columbia. These rates are much better when compared to the United States, where there are rates of greater than 50% in many hospitals. US estimates from 1997 are that costs attributed to
the treatment of resistant infections approximate $7 billion USD. If resistance levels in Canada rose to rates present in the US, drug costs alone would escalate from $660 million/year to over $1.8 billion/year; and direct hospitalization costs would rise from $14M to $187M per year. One cannot ignore the myriad of indirect costs to the patient and society as a whole, which include costs associated with losses in productivity due to a lost or impaired ability to work, patient travel time, and the intangible cost associated with pain and suffering. Over 95% of *S. aureus* are now resistant to penicillin. Other resistant bacteria include penicillin-resistant *Streptococcus pneumoniae*, vancomycin-resistant *Staphylococcus aureus* (VRSA), vancomycin-resistant *Enterococcus* (VRE), fluconazole-resistant *Candida albicans* resistant, acyclovir-resistant herpes simplex virus, 31 multi-drug resistant tuberculosis, and human immunodeficiency virus (HIV) resistance to zidovudine.

**Dental**

*Porphyromonas gingivalis, Prevotella intermedia,* and *Prevotella nigrescens* are common isolates from oral infections. Antibiotic susceptibility testing of strains of these bacteria from Spanish patients demonstrated a high incidence of beta-lactamase producing *P. gingivalis* recovered from periodontal pockets. Penicillin resistance has also been reported with *Prevotella* species, *Fusobacterium* and *Veillonella*.

High levels of resistance now being seen in the dentally-relevant alpha-hemolytic Streptococci are also a cause for concern. Susceptibility tests on 207 isolates of 9 species of alpha-haemolysic *Streptococi* that included *S. mutans, S. salivarius, S. oralis,* and *S. mitis* found that only *S. mutans* was universally susceptible to penicillin. Teng et al. also found that high-level penicillin resistance (considered to be MIC > 4mg/L) was present in 8% of *S. salivarius* strains, 20% of *S. mitis* strains, and 35% of *S. oralis* strains. Other studies have shown that MICs of benzylpenicillin for *S. oralis* and *S. mitis* ranged from 32 to 64 mg/L.

**Endodontics**

There are reports showing the emergence of resistance among endodontically-relevant bacterial species. One study estimates the prevalence of penicillin resistance among bacteria commonly found in endodontic infections approximated a range of 5-20%. Amoxicillin resistance has also been described in *Veillonella* species and *Prevotella denticola* isolated from root canals.
Penicillin resistant bacteria have also been found in the microflora of acute dental infections.\(^{43,52,53}\) One study showed that the majority of bacteria isolated from pus from a dentoalveolar abscess were gram-negative anaerobes which were highly susceptible to metronidazole and clindamycin; however, alarmingly, 22\% of the bacteria isolated produced beta-lactamase and were resistant to penicillin.\(^{169}\)

One study showed that 34\% of bacteria from dentoalveolar abscesses were resistant to penicillin.\(^{173}\) These findings put into question whether penicillin should still be considered the first line antibiotic against dentoalveolar infections.\(^{28}\) This is supported by a recent study that showed that administration of penicillin V increases emergence of beta-lactamase producing bacteria.\(^{174}\) Another study by the same group showed that over 50\% of patients acquired beta-lactamase producing bacteria when penicillin was taken for several days compared to a much lower incidence when taken for one or two days.\(^{174}\) This indicated that the percentage of beta-lactamase bacteria associated with endodontic infections increased when there was prior exposure to beta-lactam antibiotics.\(^{174}\) A similar effect was noted in a medical study where many individuals prescribed an antibiotic in primary care developed resistant bacteria to that antibiotic.\(^{175}\) The effect was greatest in the month immediately after administration, and in some cases persisted for 12 months.\(^{175}\)

Fortunately, at the present time (October 2016), most dental infections still respond to penicillins,\(^{176}\) especially amoxicillin with clavulanate.\(^{52,101}\)

2.5.2.2 Mechanism of antimicrobial resistance

Bacterial resistance to antibiotics is associated with:\(^{45}\)

- Modification of target sites/receptors
- Enzymatic inactivation of the antibiotic (e.g. production of beta-lactamases or acetyltransferases)
- Altering their cell walls or membrane permeability (limiting access of antibiotics to the target—i.e. modified penicillin binding proteins) either by deleting outer membrane pores or by closing these membrane channels
- Active antibiotic efflux pumps (usually for tetracyclines)
- Use of alternate growth requirements
- Overproduction of target sites
Appropriate antibiotic dosing is important, as subtherapeutic doses of antibiotics that do not kill the microorganism but rather allow it to perceive the chemical as a threat to its survival may allow surviving bacteria to undergo chromosomal mutation and/or acquire or transfer resistance genes that lead to microbial resistance.\(^{45}\)

Bacterial resistance specifically to penicillin, an accepted first line antibiotic for endodontic infections,\(^ {29}\) generally occurs by three mechanisms:

1) barriers to bacterial cell wall penetration\(^{101}\)
2) inability of the drug to bind to penicillin-binding proteins\(^ {101,177,178}\)
3) production of beta-lactamase\(^ {101,179}\)

Despite the known risks associated with indiscriminate prescribing of antibiotics, it appears that overprescribing still occurs. This will be looked at in depth in the next section.

## 2.6 Antibiotics: overprescribing

A Canadian pharmaceutical study reported that, in 1999, 25 million prescriptions for oral antibiotics were issued, ranking antibiotics as the third most commonly prescribed class of agents behind cardiovascular and psychotherapeutic drugs.\(^ {40}\) We have previously noted that indiscriminate use of antibiotics is considered to be a major contributor to the emergence and dissemination of antibiotic resistance.\(^ {28,40,44,54,55}\) Accordingly, with the increasing prevalence of antibiotic resistance, there is a need to carefully examine the prescribing of antibiotics in dentistry, particularly in the treatment of endodontic emergencies.

In this section, we look at the prescribing habits of dentists and physicians and the non-biomedical pressures that may alter their prescribing habits.

### 2.6.1 Dentists

It is unclear what contribution dentistry makes to the emergence of antibiotic resistance,\(^ {41}\) but it is apparent that dental-related antibiotic usage is a factor. In 1998, the Standing Medical Advisory Committee (SMAC) in the United Kingdom stated that dental-related antibiotic prescriptions account for 7% of all community prescriptions for antibiotics.\(^ {51}\) Other studies indicate that dentistry’s contributions to antibiotic resistance may be considerable since dentists account for 7-11% of the common antibiotics prescribed.\(^ {37,65}\) Sweeney et al. concluded that the
prescribing habits of dentists in the UK contributed significantly to the selection of drug resistant strains.\textsuperscript{44}

The American Dental Association (ADA), in a 1997 article, stated that: “Microbial resistance to antibiotics is increasing at an alarming rate. The major cause of this public health problem is the use of antibiotics in an inappropriate manner, leading to the selection of dominance of resistant microorganisms and/or the increased transfer of resistance genes from antibiotic-resistant to antibiotic-susceptible microorganisms.”\textsuperscript{55}

It is readily apparent from published reports that dentists are prone to prescribing antibiotics for dental conditions that do not warrant antibiotic therapy (Table 9). Table 9 further points out several factors associated with dentist overprescribing of antibiotics.

Yingling et al.’s survey of US endodontists describes the poor antibiotic prescribing habits among even some dental specialists.\textsuperscript{66} They reported that 12.5\% of endodontists prescribe antibiotics as an analgesic for the management of postoperative pain, 37.3\% as antibiotic prophylaxis following apical surgery, 44.8\% after incision and drainage without systemic involvement, and 12\% to 59\% for other endodontic presentations when antibiotics were not indicated.\textsuperscript{66} Approximately 17\% of endodontists prescribe antibiotics for irreversible pulpitis, and almost 12\% prescribe antibiotics for necrotic pulps with chronic apical periodontitis and a sinus tract.\textsuperscript{66} Some endodontists reported feeling pressures to prescribe antibiotics when non-indicated in order to satisfy patient demand, to avoid the risk of losing referrals, and to curtail possible medico-legal concerns.\textsuperscript{66}

Dar-Odeh et al., in their review of the literature, found that “the prescribing habits of dentists are inadequate and this is manifested by over-prescribing.”\textsuperscript{65} Their review also provided evidence that non-clinical factors, such as patient expectation of an antibiotic or convenience, may play a role in dentists’ prescribing habits.\textsuperscript{65}

2.6.2 Physicians

Overprescribing of antibiotics by physicians is occurring in several areas of patient care nationally\textsuperscript{56-58} and globally.\textsuperscript{59-64} In the US, the Centers for Disease Control and Prevention estimates that approximately 100 million antibiotic prescriptions are written by physicians each year, with approximately half of those appearing to be unnecessary.\textsuperscript{180} Interestingly, Canada has
one of the highest rates of use of antibiotics in the industrialized world, with a per capita rate twice that of the US. Disturbingly, approximately 25% of physicians do not believe that prior antibiotic use increased the risk of inducing antibiotic resistance, and 23.1% do not believe that antibiotic use is an important factor in promoting resistance in their communities.

Little is known about physician prescribing practices when confronted with a NTDC. Sweeney et al. have noted that, “as medical practitioners are not expert in the treatment of dental problems, it would not be surprising to find them prescribing inappropriately for dental infections that may only require surgical or mechanical intervention.” Though the literature does provide some clues that there may be overprescribing of antibiotics among physicians when treating NTDCs, there are only two quantitative papers that show this trend:

- Anderson et al., a British study that compared antibiotic prescribing tendencies for NTDCs between physicians and dentists, found that medical practitioners were more likely to prescribe antibiotics for acute dental conditions than dentists (68% of medical practitioners versus a range of 28-52% of dentists). They also reported that physicians were more likely to prescribe broad-spectrum antibiotics than dentists. And,

- The Okunseri et al. study examined US hospital data from 1997 to 2007 and showed that there was an increased rate of antibiotic prescribing for NTDCs by ED physicians over the 11-year period. The proportion of patients receiving an antibiotic for a NTDC rose from 47% to 67% over the 11-year period. Okunseri et al. suggest these findings may indicate a lack of treatment time as well as an uncertainty of diagnosis among ED physicians (possibly as a result of a lack of training and of understanding of the pathological processes involved in pulpal, periodontal and periapical disease).

While the literature does present some quantitative data like Anderson et al.’s and Okunseri et al.’s studies, there are no available studies regarding physicians’ knowledge and practices in treating specific NTDCs and no studies assessing what factors may contribute to a physician’s decision to prescribe an antibiotic in treating an NTDC.

2.6.3 Inappropriate prescribing: Why does it happen?

Conly and Zimmerman et al. conclude that inappropriate prescribing (i.e. wrong indication or use of unnecessarily broad-spectrum agents) by physicians may be due to multiple factors, that include (1) inadequacy of the physician’s knowledge and management of patients with
infectious diseases, (2) lack of awareness of guidelines, (3) patient expectations and demands (perceived or actual), (4) difficulty in distinguishing bacterial from viral infections, (5) lack of time necessary from the provider to explain why antibiotics are not indicated, (6) a physician’s desire to give the best possible treatment regardless of cost or subsequent effects, (7) failure to consider alternative treatments, (8) inappropriate use of diagnostic laboratory studies, (9) medico-legal considerations (i.e. the “safest” strategy), and (10) the belief that newer and broad-spectrum agents represent the most effective treatment.\textsuperscript{40,75}

As is evident, it is not just poor understanding or inadequate knowledge among clinicians that may lead them to overprescribe antibiotics. There are also several other papers that support the position of Conly and Zimmerman et al. that non-biomedical factors play a role in the inappropriate prescribing of antibiotics.\textsuperscript{56,71,72} In the next section, some of these non-biomedical factors are presented in greater depth.

2.6.4 Non-biomedical factors

Time and diagnostic uncertainty

It is conceivable that in clinics where a large number of patients are seen in succession each day, a clinician’s ability to make a diagnosis and provide appropriate treatment is limited by the amount of time available for each patient and therefore lead to an inappropriate prescribing of antibiotics.\textsuperscript{181} A survey of physicians by Ackerman et al. found that persistent perceived barriers to reducing prescribing indeed included time pressures and diagnostic uncertainty.\textsuperscript{61} And, in another study, 28\% of family physicians admitted to prescribing antibiotics “several times a week,” even when not sure of their medical necessity.\textsuperscript{182} In that study, 70\% of family physicians said that they did so because they did not know whether an infection was viral or bacterial, and 24\% said that it was also caused by a lack of easy-to-use diagnostic tools.\textsuperscript{182}

In a survey of physicians by Bradley, he found that 70\% of physicians reported discomfort in deciding whether to prescribe antibiotics (for reference, the 2\textsuperscript{nd} most reported discomfort, 44\%, was in deciding whether to prescribe benzodiazepines).\textsuperscript{183} A number of factors were mentioned as reasons for their discomfort in prescribing, but the commonest was lack of time (mentioned by 49\% of physicians).\textsuperscript{183}
Dentists are also prone to the same pressures that face physicians. In the United Kingdom, Palmer et al. found that dentists prescribed antibiotics when under time pressure (30% of the time) and/or if they were unable to make a definitive diagnosis (47% of the time). A similar finding was also reported by Salako et al.\textsuperscript{159}

**Expectations**

Patient expectation or demand, parental pressures and fear of losing patients are common reasons cited by physicians as factors in their decisions to prescribe or not prescribe an antibiotic.\textsuperscript{56,185}

*Patient expectations and pressures:*

- Ackerman et al. found that patient expectations were a persistent perceived barrier to reducing prescribing.\textsuperscript{61}
- Cockburn and Pit found that when physicians perceive that patients expect an antibiotic, they are 10x more likely to be prescribed.\textsuperscript{186}
- Cole reports that 55% of family physicians felt under pressure, mainly from patients, to prescribe antibiotics, even if they were not sure they were necessary.\textsuperscript{182} Furthermore, 44% of family physicians admitted that they had prescribed antibiotics to get a patient to leave the clinic. A similar proportion (45%) had prescribed antibiotics for a viral infection, knowing that they would not be effective.\textsuperscript{182}
- Stearns et al.’ study on physician prescribing of antibiotics for acute respiratory infections concluded that a prescription was associated with higher patient satisfaction.\textsuperscript{187} Mainjot et al. reported this same phenomenon in dentistry.\textsuperscript{188}

*Parental pressures:*

- Vinson and Lutz found that among physicians treating children with a cough, if a parent expected the child to receive an antibiotic, they are more likely to be prescribed.\textsuperscript{189}
- Paluck et al. report that 48.4% of physicians thought they would reduce their antibiotic prescribing if parents did not pressure them for a prescription.\textsuperscript{56} Nearly all physicians (93.5%) in their study believed that educating parents would curb expectations for antibiotics.\textsuperscript{56}
Antibiotic prescribing for common medical problems has been shown to increase the expectation and demand among patients, leading to a self-reinforcing cycle that increases the pressure placed on practitioners to prescribe antibiotics to appease patient demand.\textsuperscript{190,191}

Lewis, in an article published in the British Dental Journal article, stated: “Unfortunately, patients presenting at dental surgeries also routinely expect an antibiotics for the treatment of ‘toothache’. It is difficult to explain to the patient, and occasionally their relatives, that dental pain is an inflammatory condition that is appropriately managed by use of analgesics and local measures and not a bacterial infection that requires provision of an antibiotic. The same problematic situation is frequently encountered in general medical practice, where patients with dental pain request the provision of an antibiotic.”\textsuperscript{74}

It should be pointed out that there is also evidence that suggests that patient expectations may not be as great a factor in the prescribing of antibiotics as many clinicians believe. Palmer et al. found that dentists in the UK were generally not influenced by patient’s expectations of receiving antibiotics (8%).\textsuperscript{184} In another study by Anderson et al., it was reported that patients expectations with regard to treatment of a dental emergency does not necessarily include receiving an antibiotic, but rather, the expectation of relief of symptoms and greater certainty regarding the cause of the problem.\textsuperscript{192} Many patients suggested that their expectations were conditional and rested upon the dentist’s decision as to whether antibiotics were necessary.\textsuperscript{192} A similar finding was reported by Hamm et al.’s involving physician prescribing habits.\textsuperscript{193} They found that there was no correlation between patient satisfaction and the receiving of an antibiotic; instead, patient satisfaction was correlated with the physician spending enough time with them and their understanding of the illness at the time of discharge.\textsuperscript{193} Similar conclusions were made by Barden et al.\textsuperscript{194} and Butler et al.\textsuperscript{195} However, despite low patient expectations of receiving an antibiotic, Butler et al. found that physicians are prone to prescribing an antibiotic in order to preserve good relationships with patients.\textsuperscript{195} They concluded that patient education regarding the use of antibiotics may be an important tool in reducing demand for their use.\textsuperscript{195}
### 2.7 Supplements to Chapter 2, Tables and Figures

Table 1. Prevalence and characteristics of dental emergencies facing medical practitioners.

<table>
<thead>
<tr>
<th>Author</th>
<th>Country</th>
<th>Study type and data source</th>
<th>Prevalence</th>
<th>Other relevant findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verma et al. 2014 12</td>
<td>Australia</td>
<td>Retrospective database analysis ED Information System at Royal Hobart Hospital</td>
<td>0.9% of all ED presentations at the hospital ED in 2012 were dental in nature.</td>
<td>Dental abscesses and toothaches accounted for 66%.</td>
</tr>
<tr>
<td>Wong et al. 2012 82</td>
<td>Australia</td>
<td>Retrospective database analysis Public oral health clinic in Queensland (Jan 2008 - Aug 2010)</td>
<td>From 2008–2010, a mean of 196 ± 86 dental cases presenting at ED each month.</td>
<td>The majority of patients presented for caries related problems (74–75%), followed by trauma (8–9%).</td>
</tr>
<tr>
<td>LaPlante et al. 2015 10</td>
<td>Canada</td>
<td>Retrospective secondary data analysis</td>
<td>Data for all Ontario Health Insurance Plan (OHIP) approved billing claims were accessed over 11 fiscal years (2001-2011). Approximately 208,375 visits per year, with an average of 1,298/100,000 persons, were made to physicians for oral health-related diagnoses.</td>
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<tr>
<td>Ontario Ministry of Health and Long-Term Care 2014 84</td>
<td>Canada</td>
<td>IntelliHealth Ontario – 2014 data, retrieved from online database</td>
<td>Across Ontario, in 2014, there were almost 61,000 visits to hospital emergency departments for oral health problems.</td>
<td></td>
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<tr>
<td>Ramraj et al. 2013 1</td>
<td>Canada</td>
<td>Cross-sectional, telephone-based survey N = 1049 Canadians</td>
<td>6.1% of the sample reported visiting an ED in the past for an NTDC.</td>
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<tr>
<td>Quinonez 2011 2</td>
<td>Canada</td>
<td>Cross-sectional, telephone-based survey N = 1005 Canadians</td>
<td>5.4% of the sample reported visiting an ER in the past for an NTDC.</td>
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<tr>
<td>Quinonez et al. 2011 69</td>
<td>Canada</td>
<td>Retrospective database analysis OHIP and ED records from April 2006 - March 2007</td>
<td>In 2006-7, approximately 26,000 of 12 million Ontarians received ED, hospital, and/or physician care for dental conditions, representing a cost of $16.4 million.</td>
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<tr>
<td>Reference</td>
<td>Country</td>
<td>Study Design</td>
<td>Database Details</td>
<td>Findings</td>
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<tr>
<td>Quinonez et al. 2009</td>
<td>Canada</td>
<td>Retrospective database analysis</td>
<td>NACRS database. 2003-4 to 2005-6 fiscal years analyzed.</td>
<td>Total of 141,365 ED visits for NTDCs in Ontario, representing 116,357 persons. 54% were made by those 20 to 44 years old, and associated with periapical abscesses and toothaches (56%). 78% were triaged as non-urgent, and 93% were discharged home.</td>
</tr>
<tr>
<td>Oliva et al. 2008</td>
<td>Canada</td>
<td>Retrospective chart review</td>
<td>Records of NTDCs at a pediatric ED in 2005</td>
<td>NTDCs accounted for 0.5% of all patient visits to a paediatric ED in 2005. Half of the visits were during normal dental office hours, and more than half presented during weekdays. Most children (82%) were discharged from the ED with oral antibiotics.</td>
</tr>
<tr>
<td>Portman-Lewis 2007</td>
<td>UK</td>
<td>Retrospective record analysis</td>
<td>N = 1070 records (March 1999 - December 2003)</td>
<td>Most visits were on the weekend. The most common presenting complaint was 'toothache' in the form of acute pulpitis or periapical periodontitis, together accounting for 52.3% of all calls.</td>
</tr>
<tr>
<td>Allareddy et al. 2014</td>
<td>US</td>
<td>Retrospective database analysis</td>
<td>Nationwide ED Sample of the Healthcare Cost and Utilization Project (2008 - 2010)</td>
<td>From 2008-2010, 4,049,361 ED visits involved the diagnosis of a dental condition, which is ~1% of all ED visits occurring in the entire United States. Uninsured patients made about 40.5% of all dental condition–related ED visits.</td>
</tr>
<tr>
<td>Wall 2012</td>
<td>US</td>
<td>Retrospective database analysis</td>
<td>National Ambulatory Medical Care Survey over 11 years (1997 - 2008)</td>
<td>Dental ED visits increased from 1.15 to 1.9% of total ED visits. The largest increase in the number of dental ED visits per 1,000 persons was found among young adults 20-34 years old. Patients from all income levels participated in the increase.</td>
</tr>
<tr>
<td>Okunseri et al. 2012</td>
<td>US</td>
<td>Retrospective database analysis</td>
<td>National Hospital Ambulatory Medical Care survey (NHAMCS) (1997 – 2007)</td>
<td>NTDC visits accounted for 1.4% of all ED visits with a 4% annual rate of increase (from 1.0% in 1997 to 1.7% in 2007). Compared to private insurance enrollees, Medicaid and self-pay patients had 2–3x the odds of making a dental-related visit compared to other visit types.</td>
</tr>
<tr>
<td>Anderson et al. 2011</td>
<td>US</td>
<td>Retrospective database analysis</td>
<td>New Hampshire EDs from 2001–2008</td>
<td>ED visits for NTDCs increased from 11,067 in 2001 to 16,238 visits in 2007. Self-paying individuals and those 15–44 years old were the most frequent ED dental care users. The most frequent dental complaints (46%) were diseases of the teeth and supporting structures.</td>
</tr>
<tr>
<td>Cohen et al. 2011</td>
<td>US</td>
<td>Cross-sectional, telephone-based survey</td>
<td></td>
<td>Most respondents visiting EDs (89.4%) and physicians (51.7%) were instructed to</td>
</tr>
</tbody>
</table>
N = 401 patients  
see a dentist or given prescriptions. Respondents visiting EDs and physicians usually did not receive definitive care and subsequently visited a dentist for treatment. Lower-income respondents were more likely to seek care from an ED, while higher-income respondents were more likely to seek care from a dentist.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cohen et al. 2008(^{11})</td>
<td>United States</td>
<td>Cross-sectional, telephone-based survey</td>
<td>8.7% of respondents contacted an ED for toothache pain relief, while 20.1% contacted physicians. The majority of respondents who contacted an ED (80.5%) or a physician (82.6%) also contacted a dentist. Contacts with a dentist were reported by 58.6% of respondents. Respondents experiencing toothache pain ultimately sought definitive resolution of their pain from dentists while visiting EDs and physicians for temporary relief.</td>
</tr>
<tr>
<td>Rowley et al. 2006(^{18})</td>
<td>United States</td>
<td>Retrospective record review</td>
<td>Emergencies were: 51% trauma, 40% caries, and 9% “other” emergencies unrelated to trauma or caries. Common patient characteristics were: (1) young age; (2) non-Caucasian ethnicity; (3) Medicaid as payer; (4) no dentist; and (5) proximity to the hospital. Caries emergencies increased significantly over the study period.</td>
</tr>
<tr>
<td>Ladrillo et al. 2006(^{83})</td>
<td>United States</td>
<td>Retrospective database analysis</td>
<td>The study showed a 121% increase in ED visits for dental complaints and a 66x increase in admissions between 1997 and 2001. Overall, dental problems made up 0.4% of total paediatric ED visits. 73.4% had non-traumatic dental complaints, while 26.6% had traumatic dental complaints.</td>
</tr>
<tr>
<td>Lewis et al. 2003(^{16})</td>
<td>United States</td>
<td>Retrospective database analysis</td>
<td>During the 4-year period from 1997-2000, an estimated 2.95 million ED visits in the United States for dental complaints, averaging 738,000 visits annually. Most common treatment was a prescription rather than procedural treatment.</td>
</tr>
<tr>
<td>Dorfman et al.</td>
<td>United States</td>
<td>Cross-sectional, in-</td>
<td>Dental presentations related</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Method</td>
<td>Sample Size</td>
</tr>
<tr>
<td>-------</td>
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<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>al. 2001</td>
<td>States</td>
<td>person survey</td>
<td>N = 200 patients</td>
</tr>
<tr>
<td>Author</td>
<td>Country</td>
<td>Study type and data source</td>
<td>Assessment of knowledge</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------------</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Needleman et al. 2013</td>
<td>United States</td>
<td>Cross-sectional, mail-based survey N = 74 Massachusetts ED (MED) directors and 500 MED physicians. (22% and 12% response rates, respectively)</td>
<td>Physicians’ knowledge of the appropriate management of dental luxations and avulsions was generally good, but poor for dental fractures.</td>
</tr>
<tr>
<td>Raoof et al. 2012</td>
<td>Iran</td>
<td>Cross-sectional, mail-based survey N = 151 physicians polled</td>
<td>10.6% of physicians had high knowledge regarding TDI treatment. 98.7% of physicians were dissatisfied with their level of knowledge.</td>
</tr>
<tr>
<td>Trivedy et al. 2012</td>
<td>United Kingdom</td>
<td>Cross-sectional, in-person survey N = 103 ED physicians</td>
<td>Only 20.4% would feel comfortable in treating dental trauma.</td>
</tr>
<tr>
<td>Zaitoun et al. 2010</td>
<td>United Kingdom</td>
<td>Prospective and cross-sectional survey N = 150 patients at paediatric dental departments of Liverpool, Manchester, Sheffield</td>
<td>In 39% of TDI patients, treatment rendered by physicians was considered inappropriate.</td>
</tr>
<tr>
<td>Glendor 2009</td>
<td>Sweden</td>
<td>Narrative review Reviews papers from 1995 to 2009</td>
<td>Concludes there is a lack of knowledge among medical personnel in managing TDIs.</td>
</tr>
<tr>
<td>Subhashraj 2009</td>
<td>India</td>
<td>Cross-sectional, in-person survey N = 200 physicians</td>
<td>Only 5.5% of medical professionals knew about re-implantation (in treating avulsion). 90% of those surveyed felt they had no knowledge of dental trauma management.</td>
</tr>
<tr>
<td>Diaz et al. 2009</td>
<td>Chile</td>
<td>Cross-sectional, in-person survey n = 82 (includes paramedical technicians, general and specialist doctors, nurses)</td>
<td>The overall dental trauma knowledge among the participants was relatively poor.</td>
</tr>
<tr>
<td>Zadik 2007</td>
<td>Israel</td>
<td>Descriptive – library search of textbooks N = 9 textbooks included for review</td>
<td>First-aid textbooks and manuals provide insufficient information regarding the emergency</td>
</tr>
</tbody>
</table>
management of TDIs. Concludes that this partly explains inadequate knowledge in this topic among medical personnel.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abu-Dawoud et al. 2007</strong>²²</td>
<td>Kuwait, Bahrain, Ireland, and United Kingdom</td>
<td>Cross-sectional, in-person survey</td>
<td>N = 30 physicians and 30 dentists who graduated during 2000-2004 period</td>
<td>83.3% surveyed had not received information on how to treat tooth avulsions. 96.6% did not have any dental health education course during their studies.</td>
</tr>
<tr>
<td><strong>Lin et al. 2006</strong>⁹⁵</td>
<td>Israel</td>
<td>Cross-sectional, in-person survey</td>
<td>N = 70 military physicians and EMTs</td>
<td>Only 5.9% of all physicians received education regarding dental trauma.</td>
</tr>
<tr>
<td><strong>Holan and Shmueli 2003</strong>⁹⁶</td>
<td>Israel</td>
<td>Cross-sectional, in-person survey</td>
<td>N = 355 physicians</td>
<td>Only 4% (12 of 335 physicians) would provide an appropriate initial treatment for tooth avulsions.</td>
</tr>
<tr>
<td>Author</td>
<td>Country</td>
<td>Study type and data source</td>
<td>Knowledge findings</td>
<td>Training</td>
</tr>
<tr>
<td>----------------------</td>
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<td>----------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>Skapetis et al. 2011</td>
<td>Australia</td>
<td>Narrative review</td>
<td>Limited number of studies available regarding physician management of NTDCs. From the studies that are available, appears that:</td>
<td>(i) Primary management of such NTDCs by medical practitioners is often suboptimal.</td>
</tr>
<tr>
<td>Sardella et al. 2007</td>
<td>Italy</td>
<td>Retrospective descriptive study</td>
<td>Only 305 of 678 (45%) referring physicians included a diagnosis in their referral letter. &gt;50% were not able to make a clinical diagnosis of oral mucosal diseases. Only 40% of the provisional diagnoses (122 of 305) coincided with the diagnosis made at the specialist unit.</td>
<td></td>
</tr>
<tr>
<td>McCann et al. 2005</td>
<td>United Kingdom</td>
<td>Cross-sectional, mail-based survey</td>
<td>Of the 48 medical staff, 28% diagnosed cases correctly, compared with 88.7% of the 22 dentists.</td>
<td>Only 11 of the 21 medical schools currently incorporate teaching of oral pathology in their curricula. Limited dentistry in their curricula.</td>
</tr>
<tr>
<td>Patel and Driscoll 2002</td>
<td>United Kingdom</td>
<td>Cross-sectional, telephone-based survey</td>
<td>When presented with a scenario of a patient with a dental infection, only 29% gave the diagnosis.</td>
<td>Of the 102 in this survey, 52% had no previous training in examination of the mouth.</td>
</tr>
</tbody>
</table>
optimal empirical treatment. Only 6% said they had training as part of their undergraduate studies.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Type</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanchez et al. 1997²⁵</td>
<td>United States</td>
<td>Cross-sectional, mail-based survey</td>
<td>N = 398 paediatricians and 632 family physicians polled, 474 responses (46% response rate)</td>
<td>Paediatricians were better informed than family physicians in the areas of general dental knowledge and prevention counselling related to oral health. Most physicians received 2 hours or less of preventive dental education during medical and specialty training.</td>
</tr>
<tr>
<td>Pennycook et al. 1993²⁶</td>
<td>United Kingdom</td>
<td>Prospective clinical study</td>
<td>N = 107 patients</td>
<td>Medical staff in the department were only rarely able to make any diagnosis at all (correctness of diagnoses not assessed).</td>
</tr>
</tbody>
</table>
**Table 4. Summary of presentations and management of IP, AAA, CAA.**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Possible presenting signs and symptoms</th>
<th>Physician management</th>
<th>Definitive dental management</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Irreversible pulpitis (IP)</strong></td>
<td>• Pain or significant sensitivity to hot, cold, and/or sweet stimuli</td>
<td>• Analgesic</td>
<td>• Pulpal extirpation, or</td>
</tr>
<tr>
<td></td>
<td>• Persists following removal of stimulus</td>
<td>• Referral to dentist</td>
<td>• Extraction</td>
</tr>
<tr>
<td></td>
<td>• Spontaneous pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Difficulty in localizing pain to a specific tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Acute apical abscess (AAA); with or without systemic involvement</strong></td>
<td>• Not sensitive to hot, cold, and/or sweet stimuli (cold may even alleviate pain)</td>
<td>• Analgesic</td>
<td>• Pulpal extirpation, and/or</td>
</tr>
<tr>
<td></td>
<td>• Tooth painful to touch and/or to biting</td>
<td>• If systemic involvement, antibiotic indicated</td>
<td>• Incision and drainage of soft tissue swelling, or</td>
</tr>
<tr>
<td></td>
<td>• Spontaneous pain</td>
<td>• Monitor closely, can be life threatening if cellulitis develops</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Soft tissue swelling present</td>
<td>• Referral to dentist</td>
<td>• Extraction</td>
</tr>
<tr>
<td></td>
<td>• Tooth mobility</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Often able to localize pain to a specific tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Chronic apical abscess (CAA)</strong></td>
<td>• Not sensitive to hot, cold, and/or sweet stimuli</td>
<td>• Referral to dentist</td>
<td>• Pulpal extirpation, or</td>
</tr>
<tr>
<td></td>
<td>• Parulis or “gum boil” present (may see pus drainage)</td>
<td></td>
<td>• Extraction</td>
</tr>
<tr>
<td></td>
<td>• Mild discomfort or no pain</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Sample dental history questionnaire for physicians.

<table>
<thead>
<tr>
<th>Question</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>When did you first feel the pain? How bad is the pain on a scale of 1 to 10?</td>
<td>• Helps the clinician understand the acuteness of the situation (i.e. are analgesics needed? Is prompt referral to a dentist needed?).</td>
</tr>
</tbody>
</table>
| Are you able to identify the specific tooth that is bothering you, or just the general area? | • Pulpal pain (i.e. irreversible pulpitis) is often difficult to pinpoint to a specific tooth.  
• Periapical pain (i.e. apical abscess) can often be pinpointed to the specific tooth in question. |
| Does the pain wake you up at night?                                      | • Helps the clinician understand the acuteness of the situation (i.e. are analgesics needed? Is prompt referral to a dentist needed?).  
• Often associated with irreversible pulpitis or acute apical abscess. |
| What makes the pain better? Or worse?                                    | • Cold/hot often triggers significant pain in cases of irreversible pulpitis.  
• Cold may provide some relief in necrotic teeth (i.e. acute apical abscess). |
| Have you received any recent dental treatment?                           | • Possible dentin sensitivity or pulpitis if there is sensitivity to temperature. If there is pain to hot/cold, pulpal necrosis may be ruled out.  
• Possible high filling if there is pain on biting.  
• Possible alveolar osteitis if recent tooth extraction. |
| Is there significant swelling?                                           | • Likely abscess (often acute apical abscess, but may be of periodontal origin). |
| Is there a “gumboil”? Does the “gumboil” come and go?                    | • Likely chronic apical abscess. |
| Has this ever happened before?                                           | • If so, may be chronic apical abscess, periodontally-related, dentin sensitivity, or other. |
| Is it your own tooth or an implant?                                      | • If it is an implant, possible peri-implantitis rather than involvement of a natural tooth. |
| Do your gums bleed on brushing or when you wake up in the morning?       | • May point to a periodontal problem. |
| Do you have a bad taste in your mouth?                                  | • May point to a draining chronic apical abscess. |
| Do you have pain on biting?                                              | • Often present when acute apical abscess or cracked tooth is present.  
• Less likely to indicate irreversible pulpitis (though not always the case). |
| Is your tooth loose?                                                     | • May be acute apical abscess-related or periodontal disease. |
Table 6. "Red flags" associated with NTDCs.

<table>
<thead>
<tr>
<th>Clinical finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>• High fever (&gt;38.3°C)</td>
</tr>
<tr>
<td>• Unstable vital signs</td>
</tr>
<tr>
<td>• Difficulty breathing</td>
</tr>
<tr>
<td>• Severe trismus</td>
</tr>
<tr>
<td>• Inability to swallow</td>
</tr>
<tr>
<td>• Elevation of the floor of mouth</td>
</tr>
<tr>
<td>• Neck swelling</td>
</tr>
<tr>
<td>• Deviation of the uvula</td>
</tr>
<tr>
<td>• Bulging of the lateral pharyngeal wall</td>
</tr>
<tr>
<td>• Dehydration requiring intravenous fluids</td>
</tr>
<tr>
<td>• Infection occupying a deep fascial space that hinders access to the airway,</td>
</tr>
<tr>
<td>could directly obstruct it or threatens vital structures</td>
</tr>
<tr>
<td>• Deterioration of a patient that has been taking antibiotics</td>
</tr>
<tr>
<td>• Pain out of proportion to physical findings</td>
</tr>
<tr>
<td>• Immune system compromise</td>
</tr>
<tr>
<td>• Need for in-patient control of a systemic disease</td>
</tr>
<tr>
<td>(i.e. bleeding diathesis, hypertension)</td>
</tr>
<tr>
<td>• Need for general anaesthesia for surgical procedures</td>
</tr>
</tbody>
</table>
Table 7. Indications for adjunctive antibiotic use as recommended by the AAE.

<table>
<thead>
<tr>
<th>Clinical finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Fever &gt; 37.8 °C</td>
</tr>
<tr>
<td>• Malaise</td>
</tr>
<tr>
<td>• Lymphadenopathy</td>
</tr>
<tr>
<td>• Increased swelling</td>
</tr>
<tr>
<td>• Cellulitis or diffuse swelling</td>
</tr>
<tr>
<td>• Osteomyelitis</td>
</tr>
<tr>
<td>• Persistent infection</td>
</tr>
<tr>
<td>• Unexplained trismus (i.e. indicating spread of infection to perimandibular spaces which may extend to secondary spaces that can be potentially dangerous)</td>
</tr>
</tbody>
</table>
Table 8. Antibiotic dosing regimens as recommended by the AAE.

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Loading dose</th>
<th>Maintenance dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penicillin</td>
<td>1000 mg</td>
<td>500 mg qid</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>1000 mg</td>
<td>500 mg tid</td>
</tr>
<tr>
<td>Amoxicillin with clavulanate</td>
<td>1000 mg</td>
<td>500 mg tid</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>600 mg</td>
<td>300 mg qid</td>
</tr>
<tr>
<td>Metronidazole</td>
<td>1000 mg</td>
<td>500 mg qid</td>
</tr>
<tr>
<td>Azithromycin</td>
<td>500 mg</td>
<td>250 mg od</td>
</tr>
<tr>
<td>Clarithromycin</td>
<td>500 mg</td>
<td>250 mg bid</td>
</tr>
</tbody>
</table>
Table 9. Antibiotic prescribing by dentists for NTDCs.
(AAP = acute apical periodontitis, AAA = acute apical abscess, CAA = chronic apical abscess, CAP = chronic apical periodontitis, IP = irreversible pulpitis, GDPs = general dental practitioners)

<table>
<thead>
<tr>
<th>Author et al.</th>
<th>Country</th>
<th>Study type and data source</th>
<th>Key findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipalova et al. 2014</td>
<td>Czech Republic</td>
<td>Retrospective database review Database of General Health Insurance Company (2006-2012)</td>
<td>The proportion of antibiotic use in dentistry increased from 0.63 DID in 2006 to 0.75 DID. Found an absolute increase in the use of antibiotics by dentists and a growing trend in the number of antibiotic prescriptions per insured person per year.</td>
</tr>
<tr>
<td>Jayade 2014</td>
<td>India</td>
<td>Cross-sectional, mail-based survey 400 dentists polled, 344 responses (86% response rate)</td>
<td>42.8% would prescribe medication for non-biomedical factors such as “unsure of diagnosis.” Necrotic pulp/AAP/swelling with moderate/severe pre-op symptoms was the most common condition identified for antibiotic therapy (56.4%). Dentists prescribed antibiotics in 10% of cases of IP and 15% of cases of CAA. The first antibiotic of choice in patients with no medical allergies is amoxicillin, followed by amoxicillin and metronidazole. The first antibiotic of choice in cases of allergy to penicillin was erythromycin.</td>
</tr>
<tr>
<td>Al-Maslamani et al. 2014</td>
<td>Kuwait</td>
<td>Cross-sectional, in-person survey 169 dentists (GDPs and specialists) polled</td>
<td>14% and 22% prescribed antibiotic for reversible and irreversible pulpitis with normal periapical status, respectively. 86% participants prescribed antibiotics in cases with AAA. 24.8% prescribed antibiotics for CAA. 16% prescribe antibiotics for severe dental pain. Amoxicillin and ibuprofen were the most commonly prescribed medications. Dentists &gt; 40 yrs old prescribe antibiotics for pulpal conditions significantly more often than those &lt; 40 years old. Significantly more male dentists prescribed antibiotics than female dentists.</td>
</tr>
<tr>
<td>Saadat et al. 2013</td>
<td>Pakistan</td>
<td>Cross-sectional survey, and in-person interviews 110 GDPs polled, 89 responses (81% response rate)</td>
<td>GDPs prescribed antibiotics for cellulitis (85.4%), pericoronitis (75.2%), ANUG (70.7%), periodontal abscess (65.1%), IP (53.9%), chronic periodontitis (41.5%), chronic marginal gingivitis (24.7%), and dry socket (17.9%). Amoxicillin found to be preferred antibiotic in an acute dental infection.</td>
</tr>
<tr>
<td>Al-Huwayrini et al. 2013</td>
<td>Saudi Arabia</td>
<td>Cross-sectional survey, and in-person interviews 380 dentists polled (mixed GDPs / specialists), 303 responses (79.7%)</td>
<td>“Acceptable” level of knowledge attained by 85.5%. Scores for overall information levels about antibiotics among both specialists and GDPs were close to 70%. The percentage of specialists/GDPs with an acceptable level of knowledge on antibiotic actions was 69.2%/66.8%, 90.7%/88.7% for oral conditions and 66.7%/64.8% for medical conditions. No significant relationship was found between the</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Study Design</td>
<td>Study Details</td>
</tr>
<tr>
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<td>---------------</td>
</tr>
<tr>
<td>Sawair 2013</td>
<td>Jordan</td>
<td>Cross-sectional, mail-based survey</td>
<td>300 GDPs polled, 230 responses (76.7% response rate)</td>
</tr>
<tr>
<td>Kaptan et al. 2013</td>
<td>Turkey</td>
<td>Cross-sectional survey, and in-person interviews</td>
<td>1400 GDPs polled, 589 responses (43% response rate)</td>
</tr>
<tr>
<td>Dar-Odeh et al. 2013</td>
<td>Jordan</td>
<td>Cross-sectional survey, and in-person interviews</td>
<td>27 dentists polled (mix of GDPs and specialists)</td>
</tr>
<tr>
<td>Garg et al. 2013</td>
<td>India</td>
<td>Cross-sectional, mail-based survey</td>
<td>1600 dentists polled, 552 responses (34.5% response rate)</td>
</tr>
</tbody>
</table>
| Kumar et al. 2013 | India | Cross-sectional survey, and in-person interviews | 246 GDPs polled, 216 responses (87.8% response rate) | GDP prescribing:
(a) IP, moderate/severe pre-op symptoms -- 60.6%
(b) IP with AAP, moderate/severe pre-op symptoms -- 65.2%
(c) Necrotic pulp with CAP, no swelling, no/mild pre-op symptoms -- 44.9%
(d) Necrotic pulp with AAP, no swelling, moderate/severe pre-op symptoms -- 56.9%
(e) Necrotic pulp with CAP, sinus tract present, no/mild pre-op symptoms -- 69.4%
(f) Necrotic pulp with AAP, swelling present, moderate/severe pre-op symptoms -- 92.1%

68.5% of dentists regularly prescribed antibiotics for endodontic management. 1st antibiotic of choice for patients was a combo of amoxicillin with metronidazole, followed by amoxicillin alone. First antibiotic of choice in case of allergy to penicillin was erythromycin.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Data</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessal et al. 2011**</td>
<td>Iran</td>
<td>Cross-sectional, mail-based survey</td>
<td>450 dentists polled (mixed GDPs / specialists), 219 responses (48.6% response rate)</td>
<td>40% of GDPs prescribed antibiotics for localized fluctuant swelling and for problems for which antibiotics are not required (IP, chronic apical infection, periodontal abscess, chronic gingivitis, chronic periodontitis, pericoronitis and dry socket). Regarding antibiotic prescriptions for clinical signs, the mean knowledge score was 3.9 (range 0–6). Amoxicillin was the most frequently prescribed antibiotic for all clinical conditions but there was a wide variation in dosage, frequency and duration for all antibiotics used. A minority of practitioners (17.7%) would prescribe antibiotics as a result of a patient’s demand.</td>
</tr>
<tr>
<td>De-Bem et al. 2011</td>
<td>Brazil</td>
<td>Cross-sectional, in-person survey</td>
<td>105 endodontists polled</td>
<td>Close to 1/3 of endodontists inadequately indicated antibiotic therapy. Amoxicillin was the first choice antibiotic for 84.7%. For a scenario of penicillin allergic patients, 47.6% would prescribe clindamycin and 42.8% azithromycin. 79% indicate antibiotics administration for a period of 5 to 7 days.</td>
</tr>
<tr>
<td>Kamulegeya et al. 2011**</td>
<td>Uganda</td>
<td>Cross-sectional, mail-based survey</td>
<td>350 dentists polled, 140 responses (40.3% response rate)</td>
<td>Amoxicillin, in combination with metronidazole, was the most common combination of antibiotics used followed by co-trimoxazole with metronidazole.</td>
</tr>
<tr>
<td>Nabavizadeh et al. 2011**</td>
<td>Iran</td>
<td>Cross-sectional, mail-based survey</td>
<td>200 GDPs polled, 93 responses (46.5% response rate)</td>
<td>80.6% of GDPs prescribe antibiotics for IP, 73.1% for CAP, 58% for CAA. Amoxicillin was the drug of choice of dentists. 14% prescribe if patient insists. GDPs more recently qualified had slightly greater knowledge compared to GDPs with experience.</td>
</tr>
<tr>
<td>Segura-Egea et al. 2010**</td>
<td>Spain</td>
<td>Cross-sectional survey, and in-person interviews</td>
<td>200 oral and maxillofacial surgeons (OMFS) polled, 127 responses (64% response rate)</td>
<td>OMFS prescribing: (a) IP, moderate/severe pre-op symptoms -- 31.5%  (b) IP with AAP, moderate/severe pre-op symptoms -- 54.3%  (c) Necrotic pulp with CAP, no swelling, no/mild pre-op symptoms -- 30.7%  (d) Necrotic pulp with AAP, no swelling, moderate/severe pre-op symptoms -- 70.9%  (e) Necrotic pulp with CAP, sinus tract present, no/mild pre-op symptoms -- 59.8%  (f) Necrotic pulp with AAP, swelling present, moderate/severe pre-op symptoms -- 94.5%</td>
</tr>
</tbody>
</table>
95% of respondents selected amoxicillin as the first choice antibiotic in patients with no medical allergies, alone (34%) or associated to clavulanate (61%). The first drug of choice for patients with an allergy to penicillins was clindamycin 300 mg (65%), followed by azithromycin (15%) and metronidazole-spiramycin (13%). The average duration of antibiotic therapy was 7.0 ± 1.0 days.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Methods</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skucaite et al. 2010$^{214}$</td>
<td>Lithuania</td>
<td>Cross-sectional, mail-based survey</td>
<td>2850 GDPs polled, 1431 responses (53.8% response rate)</td>
<td>&gt;60% of GDPs prescribed antibiotics in cases of symptomatic apical periodontitis. 83.9% of GDPs reported symptomatic apical periodontitis with periostitis being a clear indication for the prescription of antibiotics. 2% of the respondents reported prescribing antibiotics in cases of IP. Amoxicillin was the most preferable antibiotic during endodontic treatment, followed by amoxicillin with clavulanate. GDPs with more years of experience prescribed antibiotics more frequently than newer grads.</td>
</tr>
<tr>
<td>Mainjot et al. 2009$^{188}$</td>
<td>Belgium</td>
<td>Cross-sectional survey / retrospective chart review (i.e. asked dentists to record info about antibiotics prescribed over a 2 week period)</td>
<td>268 GDPs. Recorded tx of 24,421 patients, with 1033 patients prescribed antibiotics</td>
<td>Antibiotics were often prescribed in the absence of fever (92.2%) and without any local treatment (54.2%). The most frequent diagnosis for which antibiotics were prescribed was periapical abscess (51.9%). Antibiotics were prescribed to 63.3% of patients with periapical abscess and 4.3% of patients with IP. The median number of prescriptions per dentist for the two weeks was 3. Broad spectrum antibiotics were most commonly prescribed: 82% of all prescriptions were for amoxicillin, amoxicillin-clavulanic acid and clindamycin. In 40.7% of prescriptions, dentists reported that there was patient demand for antibiotics. In 33.4% of prescriptions, dentists recommended that antibiotics not be taken unless symptoms become more severe.</td>
</tr>
<tr>
<td>Kyu 2009$^{215}$</td>
<td>United States</td>
<td>Cross-sectional, web-based survey</td>
<td>2593 AAE-endodontists polled, 2238 responses (37.75% response rate)</td>
<td>Compared results to Yingling et al. 2002's results (see below). Antibiotic use in cases of IP significantly dropped from 16.76% to 12%; in necrotic pulps with AAP and no swelling, a significant decline from 53.9% to 28.3%. Decreases also noted for necrotic pulp with CAP (18.8% to 16.1%), and necrotic pulp with AAP with swelling and moderate/severe symptoms, (99.2% to 92.4%). An exception was noted for CAA where there was a significant increase in antibiotic use from 11.9% to 29.1%. 50% of respondents were using antibiotics to manage post treatment flare-ups and pain. The number of prescriptions written per week decreased compared to 2002. Decrease in use of penicillin (61.48% to 43%), an increase in the use of amoxicillin (27.5% to 37.6%),</td>
</tr>
</tbody>
</table>
and an increase in use of clindamycin (45.3% to 64%) for patients with no medical allergies. For patients with medical allergies, steep incline in the use of clindamycin (56.03% to 90.3%) as first choice and in azithromycin (7.4% to 38%) as a second choice.

Many clinicians (19%) were still giving antibiotics due to soliciting of patients and referring general dentists in fear of losing referrals.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Design</th>
<th>Sample Size</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rodriguez-Nunez et al. 2009</td>
<td>Spain</td>
<td>Cross-sectional, mail-based survey</td>
<td>508 dentists polled, 140 responses (31.1% response rate)</td>
<td>For IP, 40.0% of respondents prescribed antibiotics. For the scenario of a necrotic pulp/AAP/no swelling, 52.9% prescribed antibiotics. 21.5% prescribed antibiotics for CAA. In patients with no medical allergies, most of the responders (86.1%) selected amoxicillin as the first-choice antibiotic, alone (44.3%) or associated with clavulanate (41.8%); metronidazole-spiramycin and clindamycin were prescribed by 7.6% and 3.7% of the respondents. The first drug of choice for patients with an allergy to penicillins was clindamycin 300 mg (63.2%) followed by metronidazole-spiramycin (23.7%). The average duration of antibiotic therapy was 6.8 days.</td>
<td></td>
</tr>
<tr>
<td>Lee et al 2009</td>
<td>United States</td>
<td>Cross-sectional, web-based survey</td>
<td>636 ABE endodontists polled, 232 responses (35% response rate)</td>
<td>Most frequently prescribed antibiotic among ABE diplomats was penicillin (52.5%), followed by amoxicillin (38.6) and clindamycin (20.6%). Augmentin prescribed by 3.1%.</td>
<td></td>
</tr>
<tr>
<td>Lauber et al. 2007</td>
<td>Canada</td>
<td>Cross-sectional, mail-based survey</td>
<td>1500 GDPs polled and 1500 family physicians polled (Alberta), 450 GDPs and 245 family physicians responded (GDPs 32% response rate, MDs 17% response rate)</td>
<td>Significant difference between GDPs (95%) and physicians (71%) in selecting the correct first-line antibiotic, amoxicillin, and in choosing the correct dose of amoxicillin (i.e., 2 g, 1 hour before treatment): 88% of dentists and 48% of physicians. Appropriate second-line drugs were correctly selected by 84% of dentists and 67% of physicians—a significant difference—with clindamycin chosen most often (82% and 49%, respectively). Over 90% of respondents in both professions correctly identified conditions such as prosthetic heart valve and endocarditis requiring antibiotic prophylaxis. When dentists and physicians who had been in practice for 20 years or more were compared with those in practice for less than 20 years, both groups had the same selection pattern.</td>
<td></td>
</tr>
<tr>
<td>Kakoei et al. 2007</td>
<td>Iran</td>
<td>Cross-sectional, in-person survey</td>
<td>113 dentists polled</td>
<td>Over-prescription of antibiotics in many non-indicated conditions.</td>
<td></td>
</tr>
<tr>
<td>Salako et al. 2004</td>
<td>Kuwait</td>
<td>Cross-sectional, hand-delivered survey</td>
<td></td>
<td>50% would prescribe antibiotics for cases with localized fluctuant swelling without any systemic involvement.</td>
<td></td>
</tr>
</tbody>
</table>
Amoxicillin was the most frequently prescribed antibiotic.

Many respondents would consider antibiotic prescription for non-clinical reasons such as uncertainty of diagnosis, convenience, expectation of the patient and lack of time to treat immediately. Dentists with greater experience (years) tended to have a higher mean knowledge score than those with less experience.

### Yingling et al. 2002

**United States**

Cross-sectional, mail-based survey

3203 endodontist, 1606 responses (50.1% response rate)

For IP, 16.8% of endodontists prescribed antibiotics. For the scenario of a necrotic pulp/AAP/no swelling, 53.9% prescribed antibiotics. Almost 12% prescribed antibiotics for necrotic pulps with CAA.

Penicillin VK, 500 mg qid was the first choice antibiotic prescribed by 61.5% of respondents. Clindamycin 150 mg qid was selected by 29.6%. For penicillin allergy, 57.0% prescribed clindamycin and erythromycin preparations were prescribed by 26.7%. A loading dose was used by 85.1%. The average duration of antibiotic therapy was 7.58 days.

Those respondents involved in academics, either part-time or full-time, were significantly more likely to prescribe penicillin VK 500 mg qid at a rate of 85% versus those in part-time or full-time private practice at a rate of 67%.

### Slaus et al. 2002

**Belgium**

Cross-sectional, mail-based survey

4545 dentists polled, 1143 responses (25.1% response rate)

11% of dentists prescribe antibiotics in cases of IP.

### Dailey and Martin 2001

**United Kingdom**

Prospective clinical study.

Five out-of-hours emergency clinics (over 11 weeks): patients answered first part of questionnaire pre-operatively, and dentists answered second portion of questionnaire following treatment, noting diagnosis and treatment provided

1011 patients Tx provided by 55 dentists

GDP prescribing:

Dentoalveolar abscess and IP was attributed to the cause of pain in nearly all child patients (94/99, 95%), three quarters of these children received an antibiotic prescription (76/99, 76%). The same diagnosis was attributed to over half of the adult patients with pain (464/788, 59%), of whom nearly half received an antibiotic prescription (355/788, 45%).

The majority of the attendees had pain (879/1011). 35% (311/879) of these patients had IP and 74% (230/311) had been issued a prescription for antibiotics, without any active surgical intervention.

The principal antibiotic prescribed for both adult and child patients was amoxicillin.
| **Epstein et al. 2000**<sup>158</sup> | Canada | Cross-sectional, mail-based survey | In therapeutic use, 85% of dentists followed appropriate prescription guidelines for dosing and duration of antibiotics. Antibiotics prescribed after treatment primarily were penicillin and its derivatives. Recommended adult doses of penicillin were prescribed by 59.2 percent of respondents; recommended daily doses of amoxicillin were prescribed by 72.2 percent of respondents. The average prescription duration was 6.92 days. Respondents prescribed prophylactic antibiotics an average of 1.15 times per week for prophylaxis of bacterial endocarditis. Preoperative antibiotics were prescribed for patients with a history of rheumatic fever or any heart murmur or prosthetic hip. Antibiotics were prescribed more frequently for surgical procedures and patients with acquired immunodeficiency syndrome than for other circumstances. The general pattern observed among more recent graduates was to prescribe prophylactic antibiotics at a lower rate than earlier graduates before treatment. |
| **Anderson et al. 2000**<sup>37</sup> | United Kingdom | Retrospective database review and retrospective chart review | 68% of attendances at general medical practices for tooth-related problems resulted in a prescription for antibiotics. In contrast, 28% of patients seen by a GDP clinic, 52% of patients at a weekend emergency dental clinic in a health centre, and 38% of patients attending the dental hospital clinic received antibiotics. General medical practitioners were also more likely to prescribe broad-spectrum antibiotics than dentists. |
| **Palmer et al. 2000**<sup>184</sup> | United Kingdom | Cross-sectional, mail-based survey | 12.5% of GDPs prescribed antibiotics for IP. Antibiotics were prescribed by GDPs before drainage of AAA (69%) and by 23% after drainage. Amoxicillin was most frequently prescribed antibiotic used for most clinical conditions apart from pericoronitis, acute ulcerative gingivitis and dry sockets where metronidazole was the drug of choice. Wide variety of dosage, frequency and duration for all the antibiotics used in the treatment of acute dental infections. |
GDPs were generally not influenced by patient’s expectations of receiving antibiotics (92%), but would prescribe when under pressure of time (30.3%), if they were unable to make a definitive diagnosis (47.3%), or if treatment had to be delayed (72.5%).

<table>
<thead>
<tr>
<th>Study</th>
<th>Country</th>
<th>Study Type</th>
<th>Sample Details</th>
<th>Antibiotic Prescribed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitten 1996</td>
<td>United States</td>
<td>Cross-sectional, mail-based survey</td>
<td>1000 GDPs and 500 endodontists (EN) polled, 360 GDPs and 291 endodontists responded. (36.0% and 58.2% response rate, respectively; 43.4% overall)</td>
<td>Significantly more GDP respondents prescribed antibiotics in cases of irreversible pulpitis or when a draining sinus tract was present, conditions for which relatively few EN indicated antibiotic use. The survey questioned practitioners on tx strategies for cases in which improvement is not seen after two to three days of the first-choice antibiotic therapy. The majority of GDPs (57%) chose to change antibiotics, whereas the majority of EN (49%) chose to add a second antibiotic. This additional drug was most often metronidazole. When practitioners changed antibiotics, the most popular new drug for GDPs was cephalixin (47%) and for EN was clindamycin (38%). Penicillin was the antibiotic of first choice in both groups for non-allergic patients, and was chosen significantly more by EN. For penicillin-allergic patients, erythromycin was the antibiotic of first choice in both groups. However, more than 20 percent of EN indicated that clindamycin was their first-choice agent for these patients, compared with none of the GDPs.</td>
</tr>
<tr>
<td>Gatewood et al. 1990</td>
<td>United States</td>
<td>Cross-sectional, mail-based survey</td>
<td>568 ABE endodontists polled, 314 responses (57.9% response rate)</td>
<td>3.5% prescribe antibiotics for IP without AAP, 13.7% prescribe antibiotics for IP with AAP. Necrotic/AAP/no swelling -- 33.1%. Necrotic with fluctuant swelling and drainage through pulp -- 60.5%; if no drainage, 73.2%.</td>
</tr>
<tr>
<td>Dorn et al. (Parts I and II) 223,224</td>
<td>United States</td>
<td>Cross-sectional, mail-based survey</td>
<td>396 ABE endodontists polled, 187 responses (42.9% response rate)</td>
<td>14.7% prescribe antibiotics for IP with AAP. 66.5% prescribe antibiotics for teeth with necrotic pulp and fluctuant swelling with no drainage through canal; 51.8% prescribe antibiotics for teeth with necrotic pulp and fluctuant swelling with drainage through canal. 30% prescribe antibiotics for necrotic pulp with no swelling but with pericementitis.</td>
</tr>
</tbody>
</table>
3 Materials and Methods

3.1 Study design

This study utilized a cross-sectional web-based survey via Survey Gizmo (Boulder, CO), approved by the University of Toronto Office of Research Ethics (Protocol ID 31839).

3.2 Study sample

Family physicians and emergency physicians (the two groups that are the most likely to encounter NTDCs in practice), practicing in the province of Ontario, were the target population. Based on the restrictions created by Canadian anti-spam regulations, options for contacting physicians electronically were limited (Table 10). Accordingly, the sampling frame was generated and contacts were made through Scott’s Directories (Toronto, ON), a private Canadian database-marketing solutions company. The sampling frame consisted of 1015 family physicians and 108 emergency physicians (total n = 1123 physicians); inclusion and exclusion criteria are listed in Table 11.

3.3 Survey implementation

Survey distribution was multi-modal (e-mail, fax, telephone) and based on Dillman’s principles. Four e-mail contacts and one fax contact were implemented over a two-month period from October to December 2015. In February 2016, in order to maximize the response rate, a final e-mail blast concurrent with a simultaneous telephone contact to the physicians’ offices was made, either advising their receptionists directly of the survey or leaving a voice message regarding the survey.

As the e-mail and fax contacts were implemented through a third party, it was not possible to distinguish between physicians who responded to the survey and those that did not; as such, all repeat communications were targeted to the entire sampling frame rather than specifically to only the non-respondents.

No gift or remuneration was provided to the participants in the study. The cover letter included in each e-mail contact reviewed the voluntary nature of the survey and the relevant considerations of informed consent. In addition, on the cover page of the survey where the
nature of the research was explained, it stated that submitting the survey online constituted an act of consent for physician participation. Confidentiality and data security were addressed at all levels, from survey delivery through to the protection of the integrity of the survey results and user data.

3.4 Survey instrument

The online survey tool was independently developed using Dillman’s principles and dynamically tailored questions to the specific respondent based on their previous response(s). The questionnaire was pilot-tested among 17 physicians in the Department of Family and Community Medicine at the University of Toronto to evaluate and validate the survey design, respondent burden, level of understanding, response rate, face validity, and feasibility of the planned data analysis. After adjustments were made in response to their comments, the survey instrument was finalized (Appendix A) on the basis of three principal domains, which were derived from our conceptual framework (Section 1.7, Figure 1):

- Domain 1 included questions regarding the provider’s demographic information, source/location of medical education, and level of exposure to information about dental conditions. This domain represented “Provider Characteristics” and “Source of Knowledge” in Figure 1.
- Domain 2 included questions regarding the provider’s (i) level of comfort and confidence in treating NTDCs and (ii) practices in treating NTDCs, including four clinical scenarios with specific emphasis on pharmacologic management (antibiotic and analgesic prescribing). The clinical history for all four clinical scenarios featured an adult patient in good health that presented for care due to the inability to be seen by a dentist immediately. An intra-oral clinical photo was included for each of the four clinical scenarios. The scenarios were:
  - Scenario 1, a patient with an irreversible pulpitis (IP). Prescription of an antibiotic for IP was considered as incorrect management.
  - Scenario 2, a patient with a localized acute apical abscess with no systemic involvement (LAAN). Prescription of an antibiotic for LAAN was considered as incorrect management.
Scenario 3, a patient with a localized acute apical abscess with systemic involvement (LAAS). Prescription of an antibiotic for LAAS was considered appropriate.

Scenario 4, a patient with a chronic apical abscess (CAA)—i.e. draining sinus tract. Prescription of an antibiotic for CAA was considered as incorrect management.

Analgesic prescription was considered appropriate for scenarios 1, 2, and 3 (patient in pain), but not for scenario 4 (patient not in pain).

If the survey respondent elected to prescribe an antibiotic and/or an analgesic, the respondent was then asked to list their drug of choice, the prescribed dosage, frequency of administration, and duration of use. Acceptable and non-acceptable NTDC regimens with regard to antibiotics were loosely defined as follows, based on AAE recommendations, but also allowing for some leniency as there is generally a variance in acceptable antibiotic regimens:

- Acceptable:
  - Penicillin VK; any dose in the range of 250-500 mg; tid or qid
  - Amoxicillin; any dose in the range 250-500 mg; tid or qid
  - Amoxicillin with clavulanate; any dose in the range 500-1000 mg; bid or tid
  - Clindamycin; any dose in the range 300-600 mg; tid or qid

- Not acceptable:
  - Any other first line antibiotic choice
  - Any duration < 3 days (3-10 days was considered acceptable)
  - Any dosing or frequency outside the above specified ranges for the given antibiotic selected by the respondent

This domain represented “Physicians’ Acquired Knowledge, Attitude, and Comfort Level” in Figure 1.

Domain 3 included questions regarding non-biomedical factors that affect whether the provider makes a decision to prescribe an antibiotic or not. This domain represented “Non-Biomedical Factors” and “Health Care Policy, Planning, and Regulation” in Figure 1.
3.5 Statistical considerations

3.5.1 Sample size calculation

The method described by Armstrong and Overton,\textsuperscript{226} which estimates nonresponse in surveys, was used in calculating our study sample size (n). The size of the population (N), the proportion of the population expected to choose one of two responses (P = 0.5 to allow for maximum variance), the assumed sampling error (C=0.05), and the Z-statistic of 1.96 for the 95% confidence interval (CI): 

\[ n = \frac{(N)(P)(1-P)}{(N-1)(C/Z)^2 + P(1-P)} \]

Accordingly, from the 13445 total Ontario family (n = 13131) and emergency (n = 314) physicians,\textsuperscript{227} the required sample would be 374. However, because of anticipated inability to draw a truly random sample by obtaining e-mail addresses from Scott’s Directories, and because we anticipated only a partial response rate, we opted to include all 1123 Ontario family (n = 1015) and emergency (n = 108) physicians (n = 108) from Scott’s Directories’ database.

3.5.2 Data analysis

3.5.2.1 Descriptive and bivariate analysis

Data from Survey Gizmo (Boulder, CO) was downloaded as a Microsoft Excel (Microsoft Corp, Redmond, WA) spreadsheet. After recording the variables, the database was imported into SPSS (Version 21.0, Chicago, IL) for management and analysis. The data was divided into three main sections: (1) physician demographic and educational information, (2) physicians’ practices, attitudes, and comfort in treating NTDCs, and (3) other factors that are associated with making a decision to prescribe an antibiotic for an NTDC. Responses to the questions in this survey were summarized using descriptive statistics, with analyses being conducted for the entire sample and for subgroups of the participants. Two physician subgroups were defined based on the practitioners’ primary mode of practice—(i) “family physicians,” which included those in the “All FM,” “Mostly FM, some EM,” and “Half and half” categories, and (ii) “emergency physicians,” which included those in the “Mostly EM, some FM” and “All EM” categories. Frequencies were reported, and the difference among subgroups was assessed by Pearson Chi-square test or Fisher’s exact test for categorical variables. For continuous variables, mean (standard deviation) was reported. The significance level 0.05 was applied for all statistical analysis.
3.5.2.2 Inter-scenario analysis

In order to assess whether there were significant differences between the four NTDC scenarios with regard to (i) percentage of antibiotics prescribed and (ii) percentage of narcotics prescribed, generalized estimating equations (GEEs) with repeated measurements were used. The GEE approach, which may be used for analysis of repeated categorical response data with a possible unknown correlation between outcomes (i.e. covariance structure does not need to be specified correctly in GEEs), allowed us to estimate the probability of (i) choosing to prescribe an antibiotic and (ii) choosing to prescribe a narcotic, between the four NTDC scenarios. The GEE models, which assessed for binary outcomes (antibiotic: yes/no; narcotic: yes/no) using a binomial link function, did not adjust for any outside factors and only assessed the association between the outcome of interest and the NTDC scenarios. Statistical significance was interpreted at the 5% level (P = 0.05).

3.5.2.3 Overprescribing Index and Narcotic Prescribing Index

An “Overprescribing Index” (OPI) was derived for each participant, based on the respondent’s answers to the four clinical scenarios in Domain 2. Only scenario 3 (LAAS) warranted an antibiotic prescription, while antibiotic prescription was not indicated for scenarios 1 (IP), 2 (LAAN) and 4 (CAA). For each scenario (1, 2 and/or 4) for which the respondent indicated that they would prescribe an antibiotic when an antibiotic was not indicated, 1 point was assigned. As such, OPI scores could have a defined range from a minimum value of 0 (if antibiotics were not prescribed in any of scenarios 1, 2 or 4) to a maximum value of 3 (if antibiotics were prescribed for all scenarios 1, 2 and 4). For example, if a respondent elected to prescribe antibiotics for scenarios 1 (IP) and 3 (LAAS) but not for scenarios 2 (LAAN) and 4 (CAA), the participant would receive an OPI score of 1.

A “Narcotic Prescribing Index” (NPI) was derived for each participant, based on the respondent’s answers to clinical scenarios 1 (IP), 2 (LAAN), and 3 (LAAS). As scenario 4 (CAA) featured an asymptomatic patient, this scenario was excluded from the NPI. For each scenario for which the respondent indicated that they would prescribe a narcotic analgesic, 1 point was assigned. As such, NPI scores could have a defined range from a minimum value of 0 (if narcotics were not prescribed in any of scenarios 1, 2, or 3) to a maximum value of 3 (if narcotics were prescribed for all scenarios 1, 2 and 3).
Pearson correlation coefficient between OPI and NPI scores was calculated.

### 3.5.2.4 Multivariate analysis: associations between variables of the conceptual framework and (i) high OPI, (ii) high NPI, and (iii) discomfort in overall NTDC management

Finally, associations between variables of the conceptual framework and OPI, NPI, and discomfort in overall NTDC management were analysed via multivariate analysis. First, outcome for OPI was dichotomized into “Low OPI” (scores 0 and 1) and “High OPI” (scores 2 and 3), and outcome for NPI was dichotomized into “Low NPI” (scores 0 and 1) and “High NPI” (scores 2 and 3). Then univariate logistic regression was used for different variables of the conceptual framework (see Table 12) in order to assess independent associations between the framework variables and the following three outcomes: (i) high OPI, (ii) high NPI and (iii) self-rated discomfort in overall NTDC management. Using those variables found to be significant in the univariate logistic regression (P < 0.05), a multivariate logistic model was then created, in which stepwise selection was applied (with significance level 0.05) to keep all significant covariates in the model and to remove all insignificant variables. Odds ratio (with 95% confidence interval) was reported for all univariate logistic regressions and for all variables found to be significant in the multivariate logistic model.
3.6 Supplements to Chapter 3, Tables and Figures

Table 10. Canadian medical associations who were contact and unable to issue our survey due to Canadian anti-spam legislation.

<table>
<thead>
<tr>
<th>Organizations contacted:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• College of Family Physicians Canada (CFPC)</td>
</tr>
<tr>
<td>• Royal College of Physicians and Surgeons of Canada (RCPSC)</td>
</tr>
<tr>
<td>• Canadian Association of Emergency Physicians (CAEP)</td>
</tr>
<tr>
<td>• Ontario Ministry of Health and Long-Term Care (MOHLTC)</td>
</tr>
<tr>
<td>• College of Physicians and Surgeons of Ontario (CPSO)</td>
</tr>
<tr>
<td>• Ontario Physician Human Resource Data Centre (OPHRDC)</td>
</tr>
</tbody>
</table>
Table 11. Study participant inclusion and exclusion criteria.

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ontario-based</td>
<td>• Not practicing family or emergency medicine</td>
</tr>
<tr>
<td>• Family or emergency physician, or enrolled</td>
<td>• Not currently practicing (i.e. retired)</td>
</tr>
<tr>
<td>in a family or emergency medicine residency program</td>
<td>• License limited to academia</td>
</tr>
</tbody>
</table>
Table 12. Variables regressed against (i) high OPI, (ii) high NPI, and (iii) discomfort in overall NTDC management.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment status</td>
<td>Active practitioner</td>
</tr>
<tr>
<td></td>
<td>Academia with part time practice</td>
</tr>
<tr>
<td>Primary field of practice</td>
<td>Family medicine</td>
</tr>
<tr>
<td></td>
<td>Emergency medicine</td>
</tr>
<tr>
<td>Primary work setting</td>
<td>Private office/clinic</td>
</tr>
<tr>
<td></td>
<td>Other work setting</td>
</tr>
<tr>
<td>Hours/week</td>
<td>Part-time (&lt;32 hours/week)</td>
</tr>
<tr>
<td></td>
<td>Full time (≥32 hours per week)</td>
</tr>
<tr>
<td>Practice busyness</td>
<td>Low volume (&lt; 76 patients/week)</td>
</tr>
<tr>
<td></td>
<td>Medium volume (76 to 125 patients/week)</td>
</tr>
<tr>
<td></td>
<td>High volume (&gt; 125 patients/week)</td>
</tr>
<tr>
<td>Geographic setting</td>
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</tr>
<tr>
<td></td>
<td>Small town, rural, or geographically isolated</td>
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<tr>
<td>Residency training</td>
<td>Family medicine</td>
</tr>
<tr>
<td></td>
<td>CCFP-EM program</td>
</tr>
<tr>
<td></td>
<td>FRCPC-EM program</td>
</tr>
<tr>
<td></td>
<td>Other</td>
</tr>
<tr>
<td>Years of experience</td>
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</tr>
<tr>
<td></td>
<td>6 to 15</td>
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<tr>
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<td>16 to 25</td>
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<td>26 to 35</td>
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<td>36 or more</td>
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<td>Location of medical training:</td>
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<tr>
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<tr>
<td></td>
<td>Female</td>
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<td>NTDCs seen per year</td>
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<td></td>
<td>6 to 10</td>
</tr>
<tr>
<td></td>
<td>More than 10</td>
</tr>
<tr>
<td>Statements:</td>
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</tr>
<tr>
<td>(1) “There are dentists available to whom I can refer patients without difficulty.”</td>
<td></td>
</tr>
<tr>
<td>(2) “There are dental colleagues available with whom I feel comfortable communicating and collaborating with.”</td>
<td></td>
</tr>
<tr>
<td>Hours of NTDC training:</td>
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<td>(1) Undergraduate education</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>(3) CME courses</td>
<td></td>
</tr>
<tr>
<td>Likelihood to prescribe an antibiotic for an NTDC when:</td>
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<tr>
<td>(1) A patient requests or demands one</td>
<td>Unlikely</td>
</tr>
<tr>
<td>(2) Fearing medicolegal problems if the patient deteriorates</td>
<td></td>
</tr>
<tr>
<td>(3) Unsure of the diagnosis.</td>
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</tr>
<tr>
<td>(4) Limited time to spend with the patient.</td>
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</tr>
<tr>
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<td>(1) Performing an intra-oral exam</td>
<td>Uncomfortable</td>
</tr>
<tr>
<td>(2) Prescribing analgesics</td>
<td></td>
</tr>
<tr>
<td>(3) Prescribing antibiotics</td>
<td></td>
</tr>
<tr>
<td>(4) Overall management</td>
<td></td>
</tr>
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</table>
4 Results

4.1 Descriptive results

4.1.1 Response rate

Survey invitations were e-mailed to the sampling frame of 1123 physicians, of which 58 e-mails bounced back, leaving 1065 invitations as successfully delivered. The final communication blast that included telephone calls to the 1123 phone numbers provided by Scott’s Directories (along with a simultaneous e-mail) resulted in oral contacts with 529 receptionists, messages for 210 (no receptionist available, but voice message left), and 384 physicians that were unreachable (i.e. no answering machine, number non-existent, etc.). Of the 529 offices reached, 53 reported that the specified physician was either retired or not a family or emergency practitioner; accordingly, these 53 physicians were removed from the sampling frame, leaving us with a final sampling frame of 1012. Because 384 physicians’ offices were also unreachable over the phone, it is likely that the true number of family and emergency physicians in our sampling frame was less than 1012; however, because this was unverifiable, and because the primary mode of invitation to participate in the survey was via e-mail (i.e. it is possible that the 384 physicians who were not reachable by phone still received invitation e-mails), the response rate for our study was based on a final sampling frame of 1012.

Of the 1012 invitations, 233 surveys were initiated. 204 physicians went on to complete the full survey, 23 partially completed the survey, and 6 were disqualified. Only completed surveys were considered for data analysis, as a survey exited prior to completion was interpreted as a withdrawal of consent. As such, the calculated response rate was 20.2% (204 out of 1012).

A flowchart describing this process is shown in Figure 2.

4.1.2 Practice and demographic characteristics

Practice and demographic characteristics of the survey participants are summarized in Table 13. The majority of the respondents were active practitioners (92.6%), with 67.2% practicing only family medicine and 21.1% practicing only emergency medicine. Respondents most frequently worked in a private office/clinic (49.0%), worked full-time (78.4%), saw 76 to 125 patients per week (41.2%), saw 6 to 10 NTDC patients per year (27.9%), worked in an urban/suburban
(77.0%) setting, underwent residency training in a family medicine program (70.6%), had 26 to 35 (25.0%) or 6 to 15 (25.5%) years of experience, and completed their post-graduate (94.6%) and undergraduate (94.1%) medical training in Canada. The sample most frequently consisted of males (61.4%) and of those who were 45-54 (27.5%) or 55-64 (26.0%) years of age.

Those primarily practicing emergency medicine (EM) reported seeing more NTDCs per year when compared to those primarily practicing family medicine (FM) (88.9% of EM reported seeing 11 or more NTDCs per year, versus only 22.6% of FM reporting seeing 11 or more). FM most frequently (34.0%) reported seeing 6-10 NTDCs per year.

The practice and demographic characteristics of the sample were compared with available data regarding Ontario family physicians (Table 14). For those characteristics that could be compared, differences between the sample and their Ontario counterparts were small.

4.1.3 Clinical scenario results

4.1.3.1 Antibiotics

As shown in Table 15, for scenarios 1 (IP), 2 (LAAN), and 3 (LAAS), the majority of physicians would prescribe an antibiotic (57.4%, 84.8%, and 96.3% respectively). For scenario 4 (CAA), nearly a quarter (23.5%) of the sample would prescribe an antibiotic. For all four scenarios, there were no significant differences between family and emergency physicians in electing to prescribe an antibiotic (P > 0.05). As derived from our GEE, preference for prescribing an antibiotic differed significantly between the four scenarios (P < 0.01), and as follows:

- Significantly more antibiotics were prescribed in LAAS when compared to IP (P < 0.01), LAAN (P < 0.05), and CAA (P < 0.01).
- Significantly more antibiotics were prescribed in LAAN when compared to IP (P < 0.01) and CAA (P < 0.01).
- Significantly more antibiotics were prescribed in IP when compared to CAA (P < 0.01).
Antibiotic preferences of the sample in managing NTDCs are shown in Table 16. Amoxicillin was the most commonly preferred antibiotic in each of the four scenarios and overall (41.0%). When antibiotics were selected, the antibiotic choice/dose/frequency/duration was in line with acceptable NTDC regimens (as defined in Section 3.4) in 89.8% of cases.

Respondents were also given a list of possible NTDC-associated signs or symptoms and were asked which of these would represent an indication to prescribe an antibiotic. These responses are shown in Table 17. Nearly all physicians responded that they would prescribe an antibiotic when presented with diffuse swelling (98.7%), pyrexia (97.4%), and/or chills and rigors (95.6%). 69.1% of physicians would prescribe an antibiotic for localized intraoral swelling, 46.0% for tooth pain, and 34.3% for a draining intraoral sinus tract. Significantly more family physicians would prescribe an antibiotic for chills/rigors when compared to emergency physicians (P < 0.05), while significantly more emergency physicians would prescribe an antibiotic for severe trismus when compared to family physicians (P < 0.05).

4.1.3.2 Analgesics

As shown in Table 15, for scenarios 1 (IP), 2 (LAAN), and 3 (LAAS), the majority of physicians would prescribe an analgesic (98.0%, 91.7%, and 93.7% respectively). For scenario 4 (CAA), few physicians (8.8%) would prescribe an analgesic. For scenario 4 (CAA), significantly more emergency physicians would prescribe an analgesic than would family physicians (P < 0.05).

Analgesic preferences of the sample in managing NTDCs are shown in Table 16. Most of the participants (68.2%) selected non-narcotic analgesics, with ibuprofen most commonly selected in all scenarios. Narcotics were selected 21.9% of the time for IP, 29.9% of the time for LAAN, 44.1% of the time for LAAS, and 38.9% of the time for CAA. The most frequently prescribed narcotic across all scenarios was a combination of acetaminophen/ASA with codeine (69.4% of all narcotics prescribed). Intergroup comparison from our GEE showed that preference for prescribing a narcotic differed significantly between the four scenarios (P < 0.01), and as follows:

- Significantly more narcotics were prescribed in LAAS when compared to IP (P < 0.05) and LAAN (P < 0.05).
o Significantly more narcotics were prescribed in LAAN when compared to IP (P < 0.05).

o There were no significant differences between CAA and the other three scenarios (P > 0.05).

4.1.3.3 Other management

Other management protocols for each scenario, as written in by physicians, are shown in Table 15. For scenarios 1 (IP) and 4 (CAA), no other management was written in by respondents. For scenario 2 (LAAN), 35 physicians commented that they would perform an intra-oral incision and drainage procedure of the localized swelling (26 of the 35 physicians would in addition prescribe an antibiotic). For scenario 3 (LAAS), 33 physicians stated that they would perform an incision and drainage procedure (31 of the 33 physicians would in addition prescribe an antibiotic), 9 family physicians would immediately refer the patient to a hospital emergency department, and 4 emergency physicians would immediately refer the patient to an in-hospital oral surgeon.

4.1.4 Comfort, and practices in managing NTDCs

Physician comfort levels for various aspects of NTDC management and practices in treating NTDCs are reported in Table 18. They felt least comfortable in performing an intra-oral exam (43.6%). Less than half of the sample (47.1%) felt comfortable in managing NTDCs overall. Emergency physicians reported significantly greater comfort in all aspects of NTDC management when compared to family physicians (P < 0.05), except in performing an extra-oral exam. Nearly none of the respondents (1.5%) reported using a flow sheet or checklist in managing NTDCs. In cases where an antibiotic is prescribed, the majority of physicians (52.5%) do not contact or re-examine the patient after the period of antibiotic administration. When referring patients to a dentist, the majority of physicians (69.1%) would refer patients to a dentist in private practice. About half (51.0%) of physicians agreed that there were dentists available to whom they could refer patients without difficulty, and about half (51.0%) of physicians agreed that there were dental colleagues available with whom they felt comfortable communicating and collaborating with.
4.1.5  Knowledge acquisition

Estimated numbers of hours of training received regarding NTDCs are reported in Table 19. Respondents most frequently reported receiving zero hours during their undergraduate medical education (59.8%), 1 to 5 hours during their postgraduate medical education (53.9%), and zero hours during continuing medical education (CME) courses (75.5%). In further assessing differences in post-graduate training between FM and EM, receiving zero hours of NTDC training at this level was reported by 39.6% of FM versus 4.4% of EM; 1 to 5 hours was reported by 27.7% of FM versus 53.3% of EM; and 6 or more hours was reported by 7.5% of EM versus 37.8% of EM.

Practitioner opinions about their previous education regarding NTDCs are shown in Table 19. A minority (14.7% overall; 8.8% FM, 35.6% EM) agreed that their medical training adequately prepared them to treat NTDCs, while a majority (92.7% overall; 95.0% FM, 84.4% EM) agreed that more training should be incorporated into medical school curricula regarding treatment of NTDCs. About one fifth of the sample (18.6% overall; 6.9% FM, 60.0% EM) reported having adequate training in administering intra-oral local anaesthetic for temporary pain relief, while a smaller portion of the sample (14.7% overall; 5.7% FM, 46.7% EM) reported having adequate training in the incision and drainage of localized intra-oral swellings. Very few (9.3% overall; 8.8% FM, 11.1% EM) participants reported there were management guidelines or protocols available for them to use in treating dental emergencies.

Acquiring information regarding the management of NTDCs among the sample is reported in Table 19. The most frequently reported source was dental colleagues (50.5%), followed by residency or fellowship training (49.0%), clinical experience (43.1%), and internet browsing (39.2%). When asked how likely one was to take a CME course related to NTDCs within the next 12 months, 81.4% of the sample was unlikely to do so. When asked why, 74.7% reported that no such course is available, while 54.2% reported time away from their practice as a reason they would not take such a course.

4.1.6  Non-biomedical factors

Opinions regarding “practice pressures” are reported in Table 20.
In NTDC cases where an antibiotic is not indicated based on the clinical findings, being unsure of the diagnosis (74.0%) and fear of medicolegal problems if the patient deteriorates (53.4%) were the most frequent influences that would compel the sampled physicians to prescribe an antibiotic.

The majority (68.6%) agree that most patients presenting with dental pain expect a prescription for an antibiotic, and about half (49.0%) of physicians agree that they are more likely to prescribe an antibiotic when a patient requests or demands one.

4.1.7 Overprescribing Index (OPI) and Narcotic Prescribing Index (NPI)

The frequency distribution for OPI and NPI scores are presented in Table 21.

Physicians most frequently (45.1%) received an OPI score of 2 (mean of 1.66±0.89), and 16.2% of them prescribed antibiotics for every scenario (OPI score 3). In contrast, physicians most frequently (56.4%) received an NPI score of 0 (mean of 0.88±1.140), and 15.2% of physicians prescribed narcotics for every scenario (NPI score 3).

The Pearson correlation coefficient between OPI and NPI scores was r = 0.1, indicating a weak positive relationship; however, this relationship was not statistically significant (P = 0.15).

4.2 Bivariate and multivariate analyses

4.2.1 Overprescribing Index (OPI)

Logistic regression analyses examined independent associations between variables of the conceptual framework and dichotomized OPI scores (Table 22). A high OPI score was significantly (P < 0.05) associated with physicians who:

- see a high volume of patients (>125 patients/week) (OR, 2.47; 95% CI, 1.15-5.30), as compared to those who see a low volume of patients (<76 patients/week)

- practice in small town, rural, or geographically isolated settings (OR, 3.40; 95% CI, 1.54-7.50), as compared to those who practice in urban/suburban geographic settings

- received training in a CCFP-EM program (OR, 5.47; 95% CI, 1.07-27.9), as compared to those who received training in a FRCPC-EM program
have 36 or more (OR, 6.36; 95% CI, 1.98-20.50), 26 to 35 (OR, 3.22; 95% CI, 1.28-8.10),
16 to 25 (OR, 4.41; 95% CI, 1.66-11.7), or 6 to 15 (OR, 3.06; 95% CI, 1.22-7.66) years of
experience, as compared to those who have 5 or less

had zero (OR, 2.59; 95% CI, 1.06-6.34) or 1 to 5 (OR, 2.58; 95% CI, 1.12-5.95) hours of
NTDC training in postgraduate education, as compared to those who had 6 or more

are likely to prescribe antibiotics for NTDCs when pressured by the patient (OR, 3.24; 95%
CI, 1.19-5.87), when fearing medicolegal consequences (OR, 1.82; 95% CI, 1.03-3.22),
when unsure of the diagnosis (OR, 2.20; 95% CI, 1.16-4.15), or when there is limited time to
treat (OR, 2.03; 95% CI, 1.02-4.05), as compared to those who are unlikely to do so

A multivariate logistic regression model was then constructed to determine whether these
associations retained their significance after assessing for potential confounding and interaction
effects (Table 23). It demonstrated that those who practice in smaller communities and those
who are likely to prescribe antibiotics for NTDCs when pressured by the patient are three times
more likely to have high OPI (OR, 3.04; 95% CI, 1.35-6.85 and OR, 3.01; 95% CI, 1.65-5.52,
respectively).

4.2.2 Narcotic Prescribing Index (NPI)

Logistic regression analyses examined independent associations between variables of the
conceptual framework and dichotomized NPI scores (Table 22). High NPI score was not
significantly (P < 0.05) associated with any variables of the conceptual framework. Accordingly,
no multivariate logistic regression model was constructed (Table 23).

4.2.3 Discomfort in overall NTDC management

Logistic regression analyses examined independent associations between variables of the
conceptual framework and self-reported discomfort in overall NTDC management (Table 22).
Discomfort in overall NTDC management was significantly (P < 0.05) associated with physicians who:

primarily practice family medicine (OR, 19.4; 95% CI, 6.60-56.9), as compared to those
who primarily practice emergency medicine
- see a high volume of patients (>125 patients/week) (OR, 4.48; 95% CI, 2.01-10.0), as compared to those who see a low volume (<76 patients/week)

- received training in a family medicine (OR, 16.0; 95% CI, 5.34-48.0) or CCFP-EM (OR, 5.17; 95% CI, 1.19-22.4) program, as compared to those who received training in a FRCPC-EM program

- see 0 to 5 (OR, 4.81; 95% CI, 2.39-9.66) or 6 to 10 (OR, 4.26; 95% CI, 2.05-8.86) NTDC patients per year, as compared to those who see more than 10

- had zero hours of NTDC training in undergraduate education or CME courses (OR, 6.98; 95% CI, 1.85-26.4 and OR, 21.0; 95% CI, 2.66-166, respectively), or zero (OR, 3.47; 95% CI, 1.34-8.98) or 1 to 5 (OR, 3.52; 95% CI, 1.43-8.63) hours of NTDC training in postgraduate education, as compared to those who had 6 or more

- are likely to prescribe antibiotics for NTDCs when pressured by the patient (OR, 2.86; 95% CI, 1.61-5.00), when fearing medicolegal consequences (OR, 5.56; 95% CI, 3.03-10.0), or when unsure of the diagnosis (OR, 9.09; 95% CI, 4.17-20.0), as compared to those who are unlikely to do so

- are uncomfortable in performing an intraoral exam (OR, 20.9; 95% CI, 10.0-43.0), prescribing analgesics or antibiotics for NTDC patients (OR, 47.5; 95% CI, 6.36-355 and OR, 24.5; 95% CI, 9.23-65.2, respectively), as compared to those who are comfortable doing so.

A multivariate logistic regression model was then constructed to determine whether these associations retained their significance after assessing for potential confounding and interaction effects (Table 23). The following variables retained their significance with an increased likelihood of reporting discomfort in overall NTDC management: primarily practicing family medicine (OR, 12.6; 95% CI, 4.05-39.2), having received zero hours of NTDC training in undergraduate medical education (OR, 5.29; 95% CI, 1.19-23.6), and those who are likely to prescribe antibiotics for NTDCs when unsure of the diagnosis (OR, 6.38; 95% CI, 2.66-15.3).
4.3 Summary of key findings

Overall, the majority of the sampled Ontario family and emergency physicians chose to prescribe antibiotics for NTDC case scenarios in which an antibiotic prescription was not indicated; as well, overprescribing behaviour was significantly associated with practicing in smaller communities and with patient pressures. When prescribing an analgesic for patients presenting with severe dental pain, about one third of the sample chose narcotic analgesics as their first-line choice. About half of the sampled physicians felt discomfort in overall management of NTDC patients, which was significantly associated with primarily practicing family medicine (as opposed to emergency medicine) and having received zero hours of NTDC training during undergraduate medical training. Discomfort in overall management of NTDC patients was significantly associated with being more likely to prescribe an antibiotic for an NTDC patient when unsure of the diagnosis. It should be noted that greater comfort levels in managing NTDC patients did not translate to reduced inappropriate antibiotic prescribing (i.e. family physicians, who were 12 times more likely to report discomfort in overall NTDC management, had antibiotic prescribing habits comparable to emergency physicians).
4.4 Supplements to Chapter 4, Tables and Figures

Figure 2. Survey response rate.

13445 Ontario family and emergency physicians

Sampling frame of 1123 physicians with available e-mail address

Final sampling frame $n = 1012$

Final number of usable surveys $n = 204$

Response rate $= 20.2\%$

58 e-mails bounced 53 non-eligible

233 surveys initiated 23 partial completions 6 disqualifications
Table 13. Practice and demographic characteristics of the sample (n = 204)

<table>
<thead>
<tr>
<th>Practice characteristics</th>
<th>n</th>
<th>%</th>
<th>Demographic characteristics</th>
<th>n</th>
<th>%</th>
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<td>All family medicine (FM)</td>
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<td>26 to 35</td>
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<td>45</td>
<td>22.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 to 10</td>
<td>57</td>
<td>27.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 to 20</td>
<td>38</td>
<td>18.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 20</td>
<td>38</td>
<td>18.6</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Geographic setting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban/suburban</td>
<td>157</td>
<td>77.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small town, rural, or</td>
<td>47</td>
<td>23.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>geographically isolated</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Table 14. Comparison of characteristics of the study participants with National Physician Survey* results for Ontario family physicians.

<table>
<thead>
<tr>
<th>Variables</th>
<th>This study (n = 204)</th>
<th>National Physician Survey*, Ontario data, family physicians</th>
<th>Reference year**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>%</td>
<td></td>
</tr>
<tr>
<td><strong>Practice characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary work setting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private office/clinic</td>
<td>49.0</td>
<td>59.4</td>
<td>2014</td>
</tr>
<tr>
<td>Community clinic/health centre</td>
<td>14.7</td>
<td>10.2</td>
<td></td>
</tr>
<tr>
<td>Free standing walk-in clinic</td>
<td>4.4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Emergency department</td>
<td>22.5</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Community hospital</td>
<td>5.4</td>
<td>5.8</td>
<td></td>
</tr>
<tr>
<td>Academia or research</td>
<td>2.9</td>
<td>5.7</td>
<td></td>
</tr>
<tr>
<td>Other work setting</td>
<td>1.0</td>
<td>7.8</td>
<td></td>
</tr>
<tr>
<td><strong>Number of patients seen per typical week</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low volume (&lt; 76 patients per week)</td>
<td>33.3</td>
<td>25.9</td>
<td>2010</td>
</tr>
<tr>
<td>Medium volume (76 to 125 patients per week)</td>
<td>41.2</td>
<td>31.6</td>
<td></td>
</tr>
<tr>
<td>High volume (&gt; 125 patients per week)</td>
<td>25.5</td>
<td>34.7</td>
<td></td>
</tr>
<tr>
<td><strong>Geographic setting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban/suburban</td>
<td>77.0</td>
<td>73.2</td>
<td>2014</td>
</tr>
<tr>
<td>Small town, rural, or geographically isolated</td>
<td>23.0</td>
<td>24.7</td>
<td>No response: 2.0</td>
</tr>
<tr>
<td><strong>Demographic characteristics</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years of experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36 or more</td>
<td>12.7</td>
<td>16.9</td>
<td>2010</td>
</tr>
<tr>
<td>26 to 35</td>
<td>25.0</td>
<td>19.7</td>
<td></td>
</tr>
<tr>
<td>16 to 25</td>
<td>21.1</td>
<td>21.1</td>
<td></td>
</tr>
<tr>
<td>6 to 15</td>
<td>25.5</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>5 or less</td>
<td>15.7</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>No response: 22.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-graduate training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Canada</td>
<td>94.6</td>
<td>92.9</td>
<td>2013</td>
</tr>
<tr>
<td>Outside Canada</td>
<td>5.4</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Undergraduate medical training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Canada</td>
<td>94.1</td>
<td>63.5</td>
<td>2014</td>
</tr>
<tr>
<td>Outside Canada</td>
<td>5.9</td>
<td>21.8</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 and under</td>
<td>12.7</td>
<td>10.4</td>
<td>2014</td>
</tr>
<tr>
<td>35-44</td>
<td>23.5</td>
<td>22.7</td>
<td></td>
</tr>
<tr>
<td>45-54</td>
<td>27.5</td>
<td>25.4</td>
<td></td>
</tr>
<tr>
<td>55-64</td>
<td>26.0</td>
<td>23.5</td>
<td></td>
</tr>
<tr>
<td>65 and over</td>
<td>10.3</td>
<td>17.2</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>61.3</td>
<td>55.2</td>
<td>2014</td>
</tr>
<tr>
<td>Female</td>
<td>38.7</td>
<td>44.1</td>
<td></td>
</tr>
<tr>
<td>No response: 0.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


** Not all questions are asked yearly by the National Physician Survey. For each category, the most recent polling year data has been used. For 2014, N = 1977; 2013, N = 1721; 2010, N = 2283.
### Table 15. Management of NTDC clinical scenarios.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Antibiotic prescribed n (%)</th>
<th>Analgesic prescribed n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scenario 1: Irreversible pulpitis</strong>&lt;br&gt;Family physicians (n=159)</td>
<td>89 (57.1)</td>
<td>156 (98.1)</td>
</tr>
<tr>
<td>Family physicians (n=45)</td>
<td>28 (62.2)</td>
<td>45 (100.0)</td>
</tr>
<tr>
<td>Total (n=204)</td>
<td>117 (57.4)</td>
<td>201 (98.0)</td>
</tr>
<tr>
<td><strong>Other management:</strong> None</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Scenario 2: Localized acute apical abscess, no systemic involvement**<br>Family physicians (n=159) | 136 (85.5) | 147 (92.5) |
| Family physicians (n=45) | 37 (82.2) | 40 (88.9) |
| Total (n=204) | 173 (84.8) | 187 (91.7) |
| **Other management:** 35 respondents (8 family physicians, 27 emergency physicians) wrote in that they would do incision and drainage (I&D) of the localized abscess. 26 of the 35 respondents who would do I&D would also given concurrent antibiotics. |

| **Scenario 3: Localized acute apical abscess, with systemic involvement**<br>Family physicians (n=150) | 144 (96.0) | 139 (92.7) |
| Family physicians (n=41) | 40 (97.5) | 40 (97.5) |
| Total (n=191) | 184 (96.3) | 179 (93.7) |
| **Other management:** 33 respondents (1 family physician, 32 emergency physicians) wrote in that they would do I&D of the localized abscess. 31 of the 33 respondents who would do I&D would also give concurrent antibiotics. 9 family physicians would refer to an emergency department and 4 emergency physicians would refer to an oral surgeon; these 13 physicians were removed from the total “n.” |

| **Scenario 4: Chronic apical abscess**<br>Family physicians (n=159) | 37 (23.3) | 5 (3.1) |
| Family physicians (n=45) | 11 (24.4) | 13 (28.9) |
| Total (n=204) | 48 (23.5) | 18 (8.8) |
| **Other management:** None |
Table 16. Drug preference among physicians when electing to prescribe an antibiotic and/or analgesic in scenarios 1-4.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Antibiotic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>61 (52.1)</td>
<td>73 (42.2)</td>
<td>59 (32.1)</td>
<td>21 (43.8)</td>
<td>214 (41.0)</td>
</tr>
<tr>
<td>Amoxicillin with clavulanic acid</td>
<td>8 (6.8)</td>
<td>18 (10.4)</td>
<td>43 (23.4)</td>
<td>4 (8.3)</td>
<td>73 (14.0)</td>
</tr>
<tr>
<td>Clindamycin</td>
<td>10 (8.5)</td>
<td>21 (12.1)</td>
<td>36 (19.6)</td>
<td>7 (14.6)</td>
<td>74 (14.2)</td>
</tr>
<tr>
<td>Penicillin V</td>
<td>38 (32.5)</td>
<td>59 (34.1)</td>
<td>44 (23.9)</td>
<td>14 (29.2)</td>
<td>155 (29.7)</td>
</tr>
<tr>
<td>Other*</td>
<td>0 (0.0)</td>
<td>2 (1.2)</td>
<td>2 (1.1)</td>
<td>2 (4.2)</td>
<td>6 (1.1)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* Includes preferences for cephalosporin, ciprofloxacin, clarithromycin, tetracycline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If antibiotic selected: acceptable NTDC regimen?

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1: IP (N = 201)</th>
<th>Scenario 2: LAAN (N = 187)</th>
<th>Scenario 3: LAAS (N = 179)</th>
<th>Scenario 4: CAA (N = 18)</th>
<th>All scenarios (N = 585)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Non-narcotic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acetaminophen</td>
<td>15 (7.5)</td>
<td>11 (5.9)</td>
<td>9 (5.0)</td>
<td>2 (11.1)</td>
<td>37 (6.3)</td>
</tr>
<tr>
<td>Diclofenac</td>
<td>3 (1.5)</td>
<td>2 (1.1)</td>
<td>1 (0.6)</td>
<td>0 (0.0)</td>
<td>6 (1.0)</td>
</tr>
<tr>
<td>Ibuprofen</td>
<td>82 (40.8)</td>
<td>71 (38.0)</td>
<td>55 (30.7)</td>
<td>7 (38.9)</td>
<td>215 (36.8)</td>
</tr>
<tr>
<td>Ketorolac</td>
<td>8 (4.0)</td>
<td>7 (3.7)</td>
<td>5 (2.8)</td>
<td>0 (0.0)</td>
<td>20 (3.4)</td>
</tr>
<tr>
<td>Naproxen</td>
<td>46 (22.9)</td>
<td>39 (20.9)</td>
<td>27 (15.1)</td>
<td>2 (11.1)</td>
<td>114 (19.5)</td>
</tr>
<tr>
<td>Tramadol</td>
<td>3 (1.5)</td>
<td>1 (0.5)</td>
<td>3 (1.7)</td>
<td>0 (0.0)</td>
<td>7 (1.2)</td>
</tr>
<tr>
<td>Total</td>
<td>157 (78.1)</td>
<td>131 (70.1)</td>
<td>100 (55.9)</td>
<td>11 (61.1)</td>
<td>399 (68.2)</td>
</tr>
</tbody>
</table>

Narcotic

<table>
<thead>
<tr>
<th></th>
<th>Scenario 1: IP (N = 201)</th>
<th>Scenario 2: LAAN (N = 187)</th>
<th>Scenario 3: LAAS (N = 179)</th>
<th>Scenario 4: CAA (N = 18)</th>
<th>All scenarios (N = 585)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Combination acetaminophen/ASA with codeine</td>
<td>34 (16.9)</td>
<td>42 (22.5)</td>
<td>49 (27.4)</td>
<td>4 (22.2)</td>
<td>129 (22.1)</td>
</tr>
<tr>
<td>Combination acetaminophen/ASA with oxycodone</td>
<td>4 (2.0)</td>
<td>7 (3.7)</td>
<td>18 (10.1)</td>
<td>1 (5.6)</td>
<td>30 (5.1)</td>
</tr>
<tr>
<td>Codeine</td>
<td>3 (1.5)</td>
<td>1 (0.5)</td>
<td>4 (2.2)</td>
<td>1 (5.6)</td>
<td>9 (1.5)</td>
</tr>
<tr>
<td>Oxycodone</td>
<td>3 (1.5)</td>
<td>6 (3.2)</td>
<td>8 (4.5)</td>
<td>1 (5.6)</td>
<td>18 (3.1)</td>
</tr>
<tr>
<td>Total</td>
<td>44 (21.9)</td>
<td>56 (29.9)</td>
<td>79 (44.1)</td>
<td>7 (38.9)</td>
<td>186 (31.8)</td>
</tr>
</tbody>
</table>
Table 17. Signs and symptoms—when treating an NTDC—for which an antibiotic is indicated.

<table>
<thead>
<tr>
<th>Sign or symptom</th>
<th>Total physicians (N = 204) n (%)</th>
<th>Family physicians (N = 159) n (%)</th>
<th>Emergency physicians (N = 45) n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse swelling</td>
<td>200 (98.0)</td>
<td>157 (98.7)</td>
<td>43 (95.6)</td>
<td>0.212</td>
</tr>
<tr>
<td>Pyrexia</td>
<td>196 (96.1)</td>
<td>155 (97.5)</td>
<td>41 (91.1)</td>
<td>0.073</td>
</tr>
<tr>
<td>Chills, rigors</td>
<td>188 (92.2)</td>
<td>152 (95.6)</td>
<td>36 (80.0)</td>
<td>0.002</td>
</tr>
<tr>
<td>Localized intraoral swelling</td>
<td>141 (69.1)</td>
<td>108 (67.9)</td>
<td>33 (73.3)</td>
<td>0.585</td>
</tr>
<tr>
<td>Tooth pain</td>
<td>94 (46.1)</td>
<td>74 (46.5)</td>
<td>20 (44.4)</td>
<td>1.000</td>
</tr>
<tr>
<td>Draining intraoral sinus tract</td>
<td>70 (34.3)</td>
<td>50 (31.4)</td>
<td>20 (44.4)</td>
<td>0.113</td>
</tr>
<tr>
<td>Severe trismus</td>
<td>64 (31.4)</td>
<td>40 (25.2)</td>
<td>24 (53.3)</td>
<td>0.001</td>
</tr>
</tbody>
</table>
Table 18. Practitioner self-reported comfort and practices in managing NTDCs (n = 204).

<table>
<thead>
<tr>
<th>Proportion of practitioners who report comfort in the following aspects of NTDC patient management:</th>
<th>Total physicians n (%)</th>
<th>FM n (%)</th>
<th>EM n (%)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining a verbal history</td>
<td>151 (74.0)</td>
<td>108 (67.9)</td>
<td>43 (95.6)</td>
<td>0.000</td>
</tr>
<tr>
<td>Performing extra-oral exam</td>
<td>192 (94.1)</td>
<td>147 (93.0)</td>
<td>45 (100.0)</td>
<td>0.127</td>
</tr>
<tr>
<td>Performing intra-oral exam</td>
<td>89 (43.6)</td>
<td>51 (32.1)</td>
<td>38 (84.4)</td>
<td>0.000</td>
</tr>
<tr>
<td>Prescribing appropriate analgesics</td>
<td>167 (81.9)</td>
<td>123 (77.4)</td>
<td>44 (97.8)</td>
<td>0.001</td>
</tr>
<tr>
<td>Prescribing appropriate antibiotics</td>
<td>137 (67.2)</td>
<td>99 (62.3)</td>
<td>38 (84.4)</td>
<td>0.006</td>
</tr>
<tr>
<td>Overall comfort in managing NTDCs</td>
<td>96 (47.1)</td>
<td>55 (34.6)</td>
<td>41 (91.1)</td>
<td>0.000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Do you use a flowsheet or checklist in managing patients with NTDCs?</th>
<th>Yes n (%)</th>
<th>No n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>3 (1.5)</td>
<td>201 (98.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If an antibiotic is prescribed, is the patient contacted or re-examined after the period of antibiotic administration?</th>
<th>Never n (%)</th>
<th>Some of the time n (%)</th>
<th>Most of the time n (%)</th>
<th>Always n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>107 (52.5)</td>
<td>71 (34.8)</td>
<td>17 (8.3)</td>
<td>9 (4.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>If the patient is referred to a dentist, to which type of clinic do you primarily refer?</th>
<th>Private practice n (%)</th>
<th>Hospital-based dental clinic n (%)</th>
<th>Public health dental clinic n (%)</th>
<th>University-based dental clinic n (%)</th>
<th>Other n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (%)</td>
<td>141 (69.1)</td>
<td>17 (8.3)</td>
<td>11 (5.4)</td>
<td>10 (4.9)</td>
<td>25 (12.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Practitioner agreement with the following statements:</th>
<th>Agree n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>There are dentists available to whom I can refer patients without difficulty.</td>
<td>104 (51.0)</td>
</tr>
<tr>
<td>There are dental colleagues available with whom I feel comfortable communicating and collaborating with.</td>
<td>104 (51.0)</td>
</tr>
</tbody>
</table>
Table 19. Sources of education and training regarding NTDCs (n = 204).

<table>
<thead>
<tr>
<th>Estimated number of hours of training received regarding dental disease, pain, and emergency treatment during:</th>
<th>Zero n (%)</th>
<th>1 to 5 (n %)</th>
<th>6 or more n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate medical training</td>
<td>122 (59.8)</td>
<td>68 (33.3)</td>
<td>14 (6.9)</td>
</tr>
<tr>
<td>Postgraduate (residency/fellowship) medical training</td>
<td>65 (31.9)</td>
<td>110 (53.9)</td>
<td>29 (14.2)</td>
</tr>
<tr>
<td>Continuing medical education (CME)</td>
<td>154 (75.5)</td>
<td>37 (18.1)</td>
<td>13 (6.4)</td>
</tr>
</tbody>
</table>

Practitioner agreement with the following statements:

<table>
<thead>
<tr>
<th>Agree n (%)</th>
<th>My medical training adequately prepared me to treat dental emergencies (i.e. pain, infection).</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 (14.7)</td>
<td>More training should be incorporated into medical school curricula regarding treating dental emergencies.</td>
</tr>
<tr>
<td>189 (92.6)</td>
<td>I have adequate training in administering an intra-oral local anaesthetic for temporary pain relief.</td>
</tr>
<tr>
<td>38 (18.6)</td>
<td>I have adequate training in incision and drainage of a localized intra-oral swelling.</td>
</tr>
<tr>
<td>30 (14.7)</td>
<td>There are management guidelines or protocols available to me (issued by medical or dental associations/groups) on treating dental emergencies.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>n (%)</th>
<th>Which of the following have been your greatest sources of information regarding treating NTDCs?</th>
</tr>
</thead>
<tbody>
<tr>
<td>103 (50.5)</td>
<td>Dental colleagues</td>
</tr>
<tr>
<td>100 (49.0)</td>
<td>Residency or fellowship training</td>
</tr>
<tr>
<td>88 (43.1)</td>
<td>Clinical experience</td>
</tr>
<tr>
<td>80 (39.2)</td>
<td>Internet browsing</td>
</tr>
<tr>
<td>45 (22.1)</td>
<td>Medical colleagues</td>
</tr>
<tr>
<td>44 (21.6)</td>
<td>Textbooks</td>
</tr>
<tr>
<td>26 (12.7)</td>
<td>Medical school</td>
</tr>
<tr>
<td>15 (7.4)</td>
<td>Journal articles</td>
</tr>
<tr>
<td>11 (5.4)</td>
<td>CME courses</td>
</tr>
<tr>
<td>3 (1.5)</td>
<td>Other</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Unlikely n (%)</th>
<th>Likely n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>166 (81.4)</td>
<td>38 (18.6)</td>
</tr>
</tbody>
</table>

Which of the following reasons describe why you are unlikely to take a course of this nature? (n = 166)

<table>
<thead>
<tr>
<th>n (%)</th>
<th>Which of the following reasons describe why you are unlikely to take a course of this nature?</th>
</tr>
</thead>
<tbody>
<tr>
<td>124 (74.7)</td>
<td>No such course available</td>
</tr>
<tr>
<td>90 (54.2)</td>
<td>Time away from practice</td>
</tr>
<tr>
<td>38 (22.9)</td>
<td>Lack of relevance to my practice</td>
</tr>
<tr>
<td>15 (9.0)</td>
<td>My knowledge on the subject is adequate</td>
</tr>
<tr>
<td>13 (7.8)</td>
<td>Cost of CME activities</td>
</tr>
<tr>
<td>8 (4.8)</td>
<td>Other</td>
</tr>
</tbody>
</table>
Table 20. Perceived influences of "practice pressures" (n = 204).

| Proportion of practitioners who report the following factors as being likely to influence their decision to prescribe an antibiotic for a patient presenting with an NTDC, when an antibiotic is not indicated by their clinical findings? | Total  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsure of diagnosis / etiology of patient's pain</td>
<td>151 (74.0)</td>
</tr>
<tr>
<td>Fear of medicolegal problems if the patient deteriorates</td>
<td>109 (53.4)</td>
</tr>
<tr>
<td>Limited time to spend with the patient</td>
<td>52 (25.5)</td>
</tr>
<tr>
<td>Not wanting to be perceived as doing nothing for the patient</td>
<td>25 (12.3)</td>
</tr>
<tr>
<td>Limited willingness to explain to the patient that an antibiotic is not needed</td>
<td>16 (7.8)</td>
</tr>
</tbody>
</table>

Proportion of practitioners who agree with the following statements:

| Total  
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Most patients presenting with dental pain expect a prescription for an antibiotic.</td>
<td>140 (68.6)</td>
</tr>
<tr>
<td>I am more likely to prescribe an antibiotic when a patient requests or demands one.</td>
<td>100 (49.0)</td>
</tr>
<tr>
<td>Withholding an antibiotic from a patient who specifically requests an antibiotic will impact whether this patient continues with my practice.</td>
<td>8 (3.9)</td>
</tr>
</tbody>
</table>
Table 21. Overprescribing Index (OPI) and Narcotic Prescribing Index (NPI) (n = 204).

<table>
<thead>
<tr>
<th>Index</th>
<th>Score 0 n (%)</th>
<th>Score 1 n (%)</th>
<th>Score 2 n (%)</th>
<th>Score 3 n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPI</td>
<td>24 (11.8)</td>
<td>55 (27.0)</td>
<td>92 (45.1)</td>
<td>33 (16.2)</td>
</tr>
<tr>
<td>NPI</td>
<td>115 (56.4)</td>
<td>30 (14.7)</td>
<td>28 (13.7)</td>
<td>31 (15.2)</td>
</tr>
</tbody>
</table>
Table 22. Univariate logistic regression analysis of predictors for (i) high OPI, (ii) high NPI, and (iii) discomfort in overall management of NTDCs.

<table>
<thead>
<tr>
<th>Practice characteristics</th>
<th>High OPI (Scores 2-3)</th>
<th>High NPI (Scores 2-3)</th>
<th>Discomfort in overall management of NTDCs (Uncomfortable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment status (Reference: Academia with part time practice)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active practitioner</td>
<td>1.89 (0.66, 5.56)</td>
<td>1.69 (0.46, 6.25)</td>
<td>0.98 (0.34, 2.82)</td>
</tr>
<tr>
<td>Primary field of practice (Reference: Emergency medicine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family medicine</td>
<td>0.95 (0.48, 1.89)</td>
<td>0.88 (0.43, 1.79)</td>
<td>19.4 (6.60, 56.9)</td>
</tr>
<tr>
<td>Primary work setting (Reference: Other work setting)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private office/clinic</td>
<td>1.48 (0.84, 2.61)</td>
<td>0.82 (0.45, 1.50)</td>
<td>0.57 (0.33, 1)</td>
</tr>
<tr>
<td>Hours/week (Reference: Full time (≥32 hours per week))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Part-time (&lt;32 hours/week)</td>
<td>0.62 (0.32, 1.22)</td>
<td>0.84 (0.41, 1.73)</td>
<td>0.76 (0.39, 1.49)</td>
</tr>
<tr>
<td>Practice busyness (Reference: Low volume [&lt;76 patients/week])</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium volume (76 to 125 patients/week)</td>
<td>1.80 (0.94, 3.46)</td>
<td>1.20 (0.60, 2.40)</td>
<td>1.17 (0.61, 2.22)</td>
</tr>
<tr>
<td>High volume (&gt;125 patients/week)</td>
<td>2.47 (1.15, 5.30)</td>
<td>0.64 (0.28, 1.50)</td>
<td>4.48 (2.01, 10.0)</td>
</tr>
<tr>
<td>Geographic setting (Reference: Urban/suburban)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small town, rural, or geographically isolated</td>
<td>3.40 (1.54, 7.50)</td>
<td>0.92 (0.45, 1.91)</td>
<td>1.41 (0.73, 2.78)</td>
</tr>
</tbody>
</table>

Demographic characteristics

| Residency training (Reference: FRCPC-EM program)                                         |                       |                       |                                                          |
| Family medicine                                                                         | 1.36 (0.65, 2.87)     | 0.90 (0.40, 2.00)     | 16.0 (5.34, 48.0)                                         |
| CCFP-EM program                                                                         | 5.47 (1.07, 27.9)     | 0.34 (0.06, 1.75)     | 5.17 (1.19, 22.4)                                         |
| Other                                                                                   | 0.56 (0.13, 2.34)     | 1.46 (0.34, 6.22)     | 0.86 (0.09, 8.71)                                         |
| Years of experience (Reference: 5 or less)                                              |                       |                       |                                                          |
| 36 or more                                                                              | 6.36 (1.98, 20.5)     | 1.33 (0.42, 4.23)     | 0.50 (0.18, 1.43)                                         |
| 26 to 35                                                                                | 3.22 (1.28, 8.10)     | 1.25 (0.46, 3.40)     | 0.83 (0.34, 2.04)                                         |
| 16 to 25                                                                                | 4.41 (1.66, 11.7)     | 1.03 (0.36, 2.96)     | 0.65 (0.26, 1.65)                                         |
| 6 to 15                                                                                 | 3.06 (1.22, 7.66)     | 1.46 (0.54, 3.91)     | 0.86 (0.35, 2.11)                                         |
### Post-graduate training (Reference: Within Canada)

<table>
<thead>
<tr>
<th>Outside Canada</th>
<th>Undergraduate medical training (Reference: Within Canada)</th>
<th>Gender (Reference: Female)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.73 (0.45, 6.73)</td>
<td>0.31 (0.08, 1.22)</td>
</tr>
<tr>
<td></td>
<td>3.17 (0.93, 10.8)</td>
<td></td>
</tr>
<tr>
<td>0.43 (1.3, 1.40)</td>
<td>1.83 (0.56, 6.00)</td>
<td>0.28 (0.07, 1.05)</td>
</tr>
<tr>
<td>0.31 (0.08, 1.22)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Undergraduate medical training (Reference: Within Canada)

|                |                                                          |                           |
|                | 0.43 (1.3, 1.40)                                         | 0.28 (0.07, 1.05)         |
|                | 1.83 (0.56, 6.00)                                         |                           |
| 0.31 (0.08, 1.22) |                                                          |                           |

### Gender (Reference: Female)

| Male           | 1.35 (0.76, 2.38)                                         | 0.84 (0.47, 1.47)         |
|                | 1.33 (0.71, 2.50)                                         |                           |

### Miscellaneous factors

<table>
<thead>
<tr>
<th>NTDCs seen per year (Reference: More than 10)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5</td>
<td>0.94 (0.49, 1.80)</td>
</tr>
<tr>
<td>6 to 10</td>
<td>1.86 (0.89, 3.89)</td>
</tr>
</tbody>
</table>

### Relationship with dental colleagues

<table>
<thead>
<tr>
<th>There are dentists available to whom I can refer patients without difficulty. (Reference: Agree)</th>
<th>0.76 (0.43, 1.33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>0.92 (0.5, 1.67)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>There are dental colleagues available with whom I feel comfortable communicating and collaborating with. (Reference: Agree)</th>
<th>0.98 (0.56, 1.72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disagree</td>
<td>0.98 (0.45, 1.52)</td>
</tr>
</tbody>
</table>

### Number of hours of training received regarding NTDCs

<table>
<thead>
<tr>
<th>Undergraduate medical training (Reference: 6 or more)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>1.48 (0.48, 4.56)</td>
</tr>
<tr>
<td>1 to 5</td>
<td>0.84 (0.26, 2.69)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Postgraduate medical training (Reference: 6 or more)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>2.59 (1.06, 6.34)</td>
</tr>
<tr>
<td>1 to 5</td>
<td>2.58 (1.12, 5.95)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CME courses (Reference: 6 or more)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero</td>
<td>1.50 (0.48, 4.68)</td>
</tr>
<tr>
<td>1 to 5</td>
<td>1.01 (0.28, 3.58)</td>
</tr>
</tbody>
</table>

### Comfort in various aspects of NTDC management

<table>
<thead>
<tr>
<th>Performing intra-oral exam (Reference: Comfortable)</th>
<th></th>
</tr>
</thead>
</table>

### Influence of practice pressures

<table>
<thead>
<tr>
<th>More likely to prescribe an antibiotic for an NTDC when a patient requests or demands one. (Reference: Disagree)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>3.24 (1.79, 5.87)</td>
</tr>
<tr>
<td>1.22 (0.67, 2.24)</td>
<td>2.86 (1.61, 5.00)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>More likely to prescribe an antibiotic for an NTDC when fearing medicolegal problems if the patient deteriorates. (Reference: Unlikely)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely</td>
<td>1.82 (1.03, 3.22)</td>
</tr>
<tr>
<td>0.86 (0.47, 1.58)</td>
<td>5.56 (3.03, 10.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>More likely to prescribe an antibiotic for an NTDC when unsure of the diagnosis. (Reference: Unlikely)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely</td>
<td>2.20 (1.16, 4.15)</td>
</tr>
<tr>
<td>1.04 (0.52, 2.08)</td>
<td>9.09 (4.17, 20.0)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>More likely to prescribe an antibiotic for an NTDC when limited time to spend with the patient. (Reference: Unlikely)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Likely</td>
<td>2.03 (1.02, 4.05)</td>
</tr>
<tr>
<td>1.27 (0.65, 2.51)</td>
<td>1.59 (0.84, 3.03)</td>
</tr>
<tr>
<td>Uncomfortable</td>
<td>1.14 (0.65, 2)</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Prescribing analgesics (Reference: Comfortable)</td>
<td></td>
</tr>
<tr>
<td>Uncomfortable</td>
<td>2.22 (1.00, 5.00)</td>
</tr>
<tr>
<td>Prescribing antibiotics (Reference: Comfortable)</td>
<td></td>
</tr>
<tr>
<td>Uncomfortable</td>
<td>1.20 (0.66, 2.22)</td>
</tr>
<tr>
<td>Overall comfort (Reference: Comfortable)</td>
<td></td>
</tr>
<tr>
<td>Uncomfortable</td>
<td>1.08 (0.61, 1.89)</td>
</tr>
</tbody>
</table>
Table 23. Summary of multivariate logistic regression analysis -- significant predictors for (i) high OPI, (ii) high NPI, and (iii) discomfort in overall management of NTDCs.

<table>
<thead>
<tr>
<th>Factors</th>
<th>OR (95% CI)</th>
<th>Factors</th>
<th>OR (95% CI)</th>
<th>Factors</th>
<th>OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>High OPI (Scores 2-3)</strong></td>
<td></td>
<td><strong>High NPI (Scores 2-3)</strong></td>
<td></td>
<td><strong>Discomfort in overall management of NTDCs</strong></td>
<td></td>
</tr>
<tr>
<td>Reference: Scores 0-1</td>
<td></td>
<td>Reference: Scores 0-1</td>
<td></td>
<td>Reference: Comfortable</td>
<td></td>
</tr>
<tr>
<td><strong>Geographic setting</strong></td>
<td></td>
<td>None</td>
<td></td>
<td><strong>Primary field of practice</strong></td>
<td></td>
</tr>
<tr>
<td>(Reference: Urban/suburban)</td>
<td></td>
<td></td>
<td></td>
<td>(Reference: Emergency medicine)</td>
<td></td>
</tr>
<tr>
<td>Small town, rural, or geographically isolated</td>
<td>3.04 (1.35, 6.85)</td>
<td></td>
<td></td>
<td>Family medicine</td>
<td>12.6 (4.05, 39.2)</td>
</tr>
<tr>
<td><strong>“I am more likely to prescribe an antibiotic for an NTDC when a patient requests or demands one”</strong> (Reference: Disagree)</td>
<td></td>
<td></td>
<td></td>
<td><strong>Number of hours of training received regarding NTDCs — undergraduate medical education</strong> (Reference: 6 or more)</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>3.01 (1.65, 5.52)</td>
<td></td>
<td></td>
<td>Zero</td>
<td>5.29 (1.19, 23.6)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>More likely to prescribe an antibiotic for an NTDC when unsure of the diagnosis</strong> (Reference: Unlikely)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Likely</td>
<td>6.38 (2.66, 15.3)</td>
</tr>
</tbody>
</table>


5 Discussion

This cross-sectional study was designed to evaluate the knowledge and practices of Ontario family and emergency physicians when managing patients with NTDCs, as well to identify factors associated with their prescribing behaviours.

5.1 Management of NTDC scenarios

Four NTDC clinical scenarios were used in this study as a means of investigating physicians’ preferred management.

5.1.1 Antibiotics

5.1.1.1 Descriptive results

We found that a majority of the Ontario family and emergency physicians sampled elected to prescribe antibiotics for NTDC case scenarios when an antibiotic prescription was not indicated. While pain may be clinically associated with an infection, it should be noted that antibiotics do not directly relieve endodontic pain and should be prescribed for an otherwise healthy individual only when there is systemic involvement (i.e. pyrexia, diffuse swelling, etc.). Yet, we found that the majority of physicians would prescribe antibiotics for IP (57.4%) and LAAN (84.8%), while nearly a quarter would prescribe antibiotics for CAA (23.5%). When antibiotic prescriptions for scenarios IP, LAAN and CAA are pooled, 55.2% of sampled physicians would prescribe a non-indicated antibiotic for an NTDC patient. When only IP and LAAN are pooled (CAA is less likely to present to a physician as it is often painless), 71.7% of sampled physicians would prescribe a non-indicated antibiotic. Furthermore, when the sample was presented with a list of NTDC-related signs and symptoms, “localized intraoral swelling” and “tooth pain” were selected as indications for an antibiotic prescription by 69.1% and 46.0% of the sample, respectively. LAAS, for which 96.3% of the sample would prescribe an antibiotic, was the only case scenario for which an antibiotic would be indicated. For all scenarios, there were no significant differences in the antibiotic prescribing patterns between family and emergency physicians. This was somewhat surprising given that emergency physicians are exposed to a greater number of NTDCs per year and have had additional postgraduate training in NTDC management. Our findings are in line with Okunseri et al., where in review of US hospital data over an 11-year period, physicians prescribed antibiotics 56% of the time for an NTDC,
with the Anderson et al. clinical study, where physicians prescribed antibiotics 68% of the time for an NTDC.37 It should be noted in both of these studies the authors did not identify whether the antibiotics were appropriately indicated. Our findings are also in line with studies from other areas of medicine in Canada and the United States, where it has been reported that physicians would inappropriately prescribe antibiotics 51 to 56.5% of the time for acute respiratory infections,56,57,64 82.3% of the time for acute rhinosinusitis,59 41.2% of the time for urinary tract infections60, 22% of the time for acute asthmatic presentations.63

When the respondents in our study selected antibiotics as part of their management, the antibiotic choice/dose/frequency/duration was in line with acceptable NTDC regimens approximately 90% of the time. It is interesting to note that in another study Canadian family physicians who participated selected the correct first-line antibiotic for prevention of infective endocarditis prior to dental procedures 71% of the time.218 Accordingly, we can conclude that those who participated in our study knew what antibiotic regimen to prescribe for an NTDC, but unfortunately not when the prescription was appropriate.

5.1.1.2 Overprescribing Index (bivariate and multivariate analysis)

Our bivariate analysis found significant associations with high OPI for 7 variables from our conceptual framework. Following analysis with a multivariate logistic regression model, only two factors retained significant associations with high OPI: (i) practicing in smaller communities (when compared to those practicing in urban/suburban areas), and (ii) being likely to prescribe antibiotics for NTDCs when pressured by the patient.

Practicing in smaller communities may be associated with reduced density and availability of dental professionals as compared to a dense demographic of dentists in major urban centres.229,230 This may act as a barrier in patient access to dental professionals for definitive treatment of NTDCs, possibly leading to a greater impetus for physicians in these smaller communities to prescribe antibiotics for these patients, particularly due to possible longer wait times for patients needing definitive dental care. Furthermore, it is not surprising to see an association of high OPI with physicians who are likely to prescribe antibiotics for NTDCs when pressured by a patient. Patient pressures, perceived or real, are known to play a role in physician prescribing practices.195
It is interesting that number of NTDCs seen per year and years of experience were not found to be significantly associated with OPI in the final statistical model. Intuitively, one would expect that increased exposure to NTDC patients would lead to more appropriate treatment decisions, but this was not the case in our study. We also anticipated that fewer years of experience would be associated with lower OPI scores, due to more recent and up-to-date education. While those with 5 or less years of experience were found to have significantly lower OPI scores in the bivariate analysis, this association was not significant in the multivariate model. This is in line with Lauber et al.’s study of Canadian family physicians and dentists, which found that physicians and dentists who had been in practice for 20 years or more had the same selection of antibiotic use and antibiotic regimens (for prophylaxis of infective endocarditis prior to dental procedures) as those in practice for less than 20 years. 

5.1.2 Analgesics

In our survey, scenarios 1 (IP), 2 (LAAN), and 3 (LAAS) all warranted analgesics, as the clinical scenario described the patient as presenting with “severe pain” (scenario CAA did not warrant an analgesic, as the patient was described as having no pain). When an analgesic was prescribed by the sample, a non-narcotic was selected about two-thirds of the time (narcotics were selected the other third of the time). Ibuprofen and combination of acetaminophen/ASA with codeine were the most frequently selected non-narcotic and narcotic, respectively. Narcotics were selected significantly more often for LAAS (44.1%) when compared to LAAN (29.9%) and IP (21.9%), and significantly more often for LAAN when compared to IP. Because scenarios 1-3 (IP, LAAN, LAAS) all similarly described a patient with “severe pain,” it is noteworthy that significantly more narcotics were prescribed as the scenarios progressed. It is plausible that the respondents associated the localized swelling in scenario 2 (LAAN) as a sign of greater severity when compared to scenario 1 (IP), and then, subsequently, the addition of systemic involvement in scenario 3 (LAAS) as a sign of even further severity.

5.1.2.1 Narcotic Prescribing Index (bivariate and multivariate analysis)

Bivariate and multivariate analyses were unable to identify any significant associations of factors from the conceptual framework with high NPI. There does appear to be a trend of high NPI associated with post-graduate training outside Canada (OR 3.17; 95% CI, 0.93-10.8); however, this trend was not found to be statistically significant and needs to be interpreted with
some degree of caution. Overall, it is unclear what factors may influence a physician’s decision to prescribe a narcotic rather than a non-narcotic.

5.2 Comfort and practices in managing NTDCs

5.2.1 Comfort levels

5.2.1.1 Descriptive

Physicians reported good comfort levels for most individual aspects of NTDC patient management, except for performing intra-oral examinations (only 43.6% reported comfort); yet, less than half (47.1%) of the sample reported comfort in overall NTDC patient management. For all aspects of NTDC patient management except extra-oral examination, emergency physicians reported significantly more comfort than family physicians.

5.2.1.2 Discomfort in overall NTDC management (bivariate and multivariate analysis)

Our bivariate analysis found significant associations with discomfort in overall NTDC management for 8 variables from our conceptual framework. Following analysis with a multivariate logistic regression model, only three factors retained significant associations: (i) primarily practicing family medicine, (ii) having received zero hours of NTDC training in undergraduate medical education (when compared to those who had 6+ hours), and (iii) being likely to prescribe antibiotics for NTDCs when unsure of the diagnosis.

As those who practice family medicine generally encounter less NTDCs compared to those who practice emergency medicine, it follows that these practitioners would be expected to have greater discomfort in managing NTDC patients due to their more limited exposure. It is also logical that those who received zero hours of NTDC training during their undergraduate medical education would have greater discomfort in overall NTDC management when compared to those who had 6 or more hours. And, finally, the finding that discomfort in overall NTDC management was associated with being likely to prescribe antibiotics for NTDCs when unsure of the diagnosis is also not unexpected. It is noteworthy that greater comfort levels in managing NTDC patients did not translate to reduced inappropriate antibiotic prescribing. Family physicians, who were significantly more likely to report discomfort in overall NTDC management, had inappropriate antibiotic prescribing habits comparable to emergency physicians.
5.2.2 Use of flowcharts / guidelines

Only 3 physicians out of our sample of 204 reported using a flowchart in managing patients with NTDCs. This points to a lack of such guideline in the general medical forum readership at this time. Hence, this study suggests that having guidelines developed by regulatory medical bodies (such as the College of Physicians and Surgeons of Ontario) and widespread dissemination of these guidelines may be an important strategy to improve physician knowledge of appropriate care when treating patients with NTDCs. Further discussion of the utility of guidelines is presented below.

5.2.3 Interprofessional relationships

We found that when referring to a dentist, the majority of physicians would refer patients to a dentist in private practice. About half of physicians felt that there were dentists available to whom they could refer patients without difficulty, and about half of physicians felt that there were dentists available with whom they felt comfortable communication and collaborating with. Interestingly, when physicians were asked about their greatest sources of information regarding NTDCs, the most popular response (50.5% of the sample) was dental colleagues. While it is unclear whether collaboration between physicians and dentists leads to superior patient outcomes, it can be deduced that greater collaboration and stronger interprofessional relationships leads to quicker referrals, which could reduce the time until a patient may receive definitive dental treatment. As only about half of the physician sample felt positive about their relationships with their dental colleagues, this points to an area for potential growth and improvement, which could lead to better care for NTDC patients seen in medical practice.

5.3 Knowledge acquisition

The majority of the sample reported receiving zero hours of NTDC training during their undergraduate medical education and CME courses, while one third of the sample reported receiving zero hours of NTDC training during their postgraduate medical education. Furthermore, less than 15% of the sample felt that their medical training adequately prepared them to treat dental emergencies. These findings are consistent with the conclusion drawn by Skapetis et al. that there is a lack of education and training in dental emergencies in the medical training process. This identifies a need for additional preparation regarding NTDCs for
physicians who will encounter them in practice, particularly as inadequacy of knowledge may be associated with inappropriate prescribing.⁴⁰

A small portion of the sample reported having adequate training in administering intra-oral local anaesthetic (18.6%) and in incision and drainage procedures of localized intra-oral swellings (14.7%). Both skills may be beneficial to the physician in providing interim care for patients presenting with NTDCs. In fact, in both scenarios 2 (LAAN) and 3 (LAAS), close to 17% of the sample (mostly emergency physicians) wrote in that they would perform an intra-oral incision and drainage procedure. Further discussion of these modalities is presented below.

Of those who reported that they were unlikely to take a CME course covering topics related to dental pain/emergencies within the next 12 months, the most common reason (approximately 75%) for not pursuing such a course was that no such course is available. This identifies a need and potential opportunity for development of a CME course covering these topics.

5.4 Practice pressures

Our survey presented the sample with several practice- and patient-specific pressures, in order to understand which they felt would be likely to influence their decision to prescribe an antibiotic, particularly when an antibiotic was not indicated by their clinical findings. Being unsure of the diagnosis and fear of medicolegal repercussions if the patient worsened were the two most commonly selected factors that would influence their prescribing practice. These factors were identified in previous studies.⁶¹,¹⁸² Particularly, in Cole’s 2014 survey of general medical practitioners (GMPs), 28% of GMPs admitted prescribing antibiotics “several times a week,” even when not sure of their medical necessity, with over two thirds (70%) saying that they did so because they did not know whether an infection was viral or bacterial, and a quarter (24%) saying that this was because of a lack of easy to use diagnostic tools.¹⁸² Fear of medicolegal problems has also been identified as a deciding factor in a previous study.¹⁹⁵ On the other hand, limited time to spend with the patient was selected by only a quarter of our study sample, while not wanting to be perceived as doing nothing for the patient and limited willingness to explain to the patient that an antibiotic is not needed were far less popular responses. All three of these influences had been previously identified in a qualitative study by Butler et al., which featured interviews with 21 GMPs¹⁹⁵; however, they all seemed to play little role in our sample’s decision-making process.
A majority of our sample agreed that most patients presenting with dental pain expect a prescription for an antibiotic, and about half of the sample said they were more likely to prescribe an antibiotic when a patient requests or demands one. These findings are consistent with previous surveys of physicians. For example, in the Cole study, 55% of GMPs reported feeling under pressure from patients to prescribe antibiotics, even if they were not sure that they were necessary (in fact, 45% reported prescribing antibiotics for a viral infection, knowing that they would not be effective), while 44% reported prescribing antibiotics in the past in order to get a patient to leave the clinic. Bradley previously reported that a physician may unnecessarily prescribe an antibiotic for a patient who specifically requests one, as not prescribing an antibiotic may impact whether this patient continues with their practice; however, in our sample, very few physicians reported this as an influential factor in their decision-making.

5.5 Summary of findings

Within the limitations of this study (see section 5.6 below), the responses of surveyed Ontario family and emergency physicians reflected that:

1) The majority chose to prescribe antibiotics for NTDC case scenarios in which an antibiotic prescription was not indicated.

2) Overprescribing behaviour was significantly associated with practicing in smaller communities and with patient pressures.

3) There were no significant differences in antibiotic prescribing habits between family and emergency physicians.

4) When the respondents selected antibiotics as part of their management, the antibiotic regimen was in line with acceptable NTDC regimens 90% of the time (regardless of whether or not there was an appropriate indication).

5) When prescribing an analgesic for patients presenting with severe dental pain, about one third of the sample chose narcotic analgesics as their first-line choice.

6) About half of the sampled physicians felt discomfort in overall management of NTDC patients, which was significantly associated with primarily practicing family medicine (as opposed to emergency medicine) and having received zero hours of NTDC training during undergraduate medical training. Discomfort in overall management of NTDC
patients was also significantly associated with being more likely to prescribe an antibiotic for an NTDC patient when unsure of the diagnosis.

7) Greater comfort levels in managing NTDC patients did not translate into reduced inappropriate antibiotic prescribing.

8) A very small minority reported availability/use of guidelines in managing NTDCs.

9) A minority reported adequate knowledge in intra-oral local anaesthetic and intra-oral incision and drainage techniques. A greater proficiency in these techniques was found among emergency physicians.

10) About half of the sample reported positive relationships with dental colleagues.

11) Only 15% of the sample felt that their medical training adequately prepared them to treat dental emergencies, while 92.6% felt that more NTDC training should be incorporated into medical school curricula.

12) The sample identified various patient- and practice-related pressures that would influence their decision whether to prescribe an antibiotic or not when an antibiotic is not indicated by clinical findings.

5.6 Limitations of this study

5.6.1 Cross-sectional research

Considering the nature of the question, we implemented the most appropriate study design, a survey. As per the nature of any cross-sectional research, this study, at best, reflects a snapshot of the knowledge and practices of the sample. The results could be different were another time frame or geographic region selected.

Survey research includes a multitude of steps: definition of survey research objectives, identification of the type of data to be collected, specification of the population of interest, development of a sampling frame, calculation of the sample size, selection of the sample, development of the survey tool, pilot testing of the survey tool, and, finally, implementation of the survey.\(^{225,232}\) This is followed by collection, coding, cleaning, and analysis of the collected data.\(^{225,232}\) Survey research must also consider confidentiality, ethics, resource requirements, response rate, and quality of the collected data.\(^{225,232}\) Our study used a web-based survey rather than a more traditional mail-based survey. Advantages of web-based surveys when compared to mail-based include lower costs, reduced dissemination and response time, the ability to tailor the survey based on the respondent’s previous answers (i.e. automated piping, branching, skips),
and automated electronic data collection and entry. However, one of the main disadvantages of web-based surveys is the relatively high non-response rate compared to more traditional modes of data collection.

### 5.6.2 Response rate, nonresponse error, and sampling frame

Response rate (the percentage of completed surveys submitted divided by the number of individuals in the total sample frame) is often interpreted as an indicator of a sample’s representativeness and validity of the findings. A higher response rate, which is usually associated with lower nonresponse error, is assumed to increase generalizability and confidence that the responding sample accurately reflects the population of interest. Nonresponse error occurs when sampling units selected for a sample are not interviewed. For example, a respondent may be on vacation for the duration of the data collection period, or a respondent may be unwilling to take the survey because they are uninterested in the subject matter, fear embarrassment or violations of privacy, do not trust the researcher, or simply do not want to take the survey. Cunningham et al. report lack of time/survey burden as the main reason for physician nonresponse to surveys; however, nonresponse likely involves a complex interaction of survey design factors and behavioural issues that can make the effect of nonresponse bias unpredictable. Nonresponse is a problem for survey quality because it may introduce systematic bias into the data. Nonresponse may be either (i) missing completely at random (MCAR) or (ii) systematic. If nonresponse is MCAR, then there is no underlying reason why certain sampling units failed to complete the survey; in this case, nonresponse would introduce no bias into the results because there is no systematic skew in the data. Systematic bias occurs when there is some underlying reason why sampling units do not participate in the survey; this biases any results based upon the data to the extent to which respondents differ from nonrespondents on variables of importance to the analysis.

Every effort was made within the study’s budget to achieve a maximum response rate, including using e-mail/fax/telephone reminders and replacement surveys, having non-threatening survey questions, using appropriately designed questionnaires (and a priori pilot testing among a small group of comparative physicians), and assuring confidentiality and anonymity. Ultimately, our survey had a response rate of 20.2%. A response rate of 5.7%-38% is common in web-based surveys of health care professional groups; therefore, our response rate is within the expected range for our target group. Response rates for
traditional mail-based surveys of a similar population (Ontario physicians) was reported at a range of 46.6% - 68.3%\textsuperscript{243-246}. While there were no previous web-based surveys targeting the same population as our survey, response rates for web-based surveys of Canadian physicians are reported as being quite variable, with a range of 8.6% - 49.1%.\textsuperscript{237,247-259}

It should be noted that response rates with physicians often average about 10% lower than studies with the general population.\textsuperscript{260} Various factors may account for this: (i) physicians have demanding work schedules, and thus participating in a survey represents a high opportunity cost to them; (ii) physicians are frequently approached for surveys, making them more reluctant to participate; and (iii) physicians typically have receptionists or other “gatekeepers” whose job includes protecting them from unwanted intrusions on their time.\textsuperscript{260} Flannigan reports that, although maintaining high response rates is desirable, evidence indicates that physician surveys are more resilient to the effects of survey non-response than other types of surveys.\textsuperscript{260} Studies of physician surveys have compared responders and non-responders in terms of background characteristics, with most studies showing no or only minimal amounts of response bias.\textsuperscript{260} Furthermore, several studies with physicians have shown that higher response rates are not associated with lower response bias.\textsuperscript{260} Asch et al. suggest that a survey’s response rate is at best an indirect indication of the extent of non-respondent bias, and attention should instead be devoted more to assessments of bias and less to specific response rate thresholds.\textsuperscript{261} In order to assess the potential impact of nonresponse bias in our study, we took two measures:

Firstly, in order to assess the representativeness of our sample and its generalizability to the general Ontario physician pool, our sample characteristics were compared with characteristics of Ontario family physicians from the most recent National Physician Survey (NPS) data available (Table 14).\textsuperscript{262} Because the NPS data is itself derived from a survey (usually consisting of a sample of 1700-2300 Ontario physicians) rather than from a census, assessing for statistical differences between our sample and the NPS data was not possible (census data would be needed in order to perform such an analysis); however, the characteristics of our sample appear to be qualitatively in line with the NPS data. This points to our sample being representative of Ontario physicians such that there was unlikely to be a significant response bias, even though our achieved sample size (n = 204) fell short of our a priori calculated sample size (n = 374). Nonetheless, because comparison of our sample with the NPS data cannot be verified
statistically, some caution should be exercised in interpreting the representativeness of our sample.

Secondly, it is accepted that those with an interest in the content of a survey are more likely to reply, and thus it can be argued that respondents and non-respondents will have different characteristics causing a non-response bias that may limit the generalizability of the results. In our case, it is likely that emergency physicians would have greater interest in the topic of interest when compared to family physicians, based on their greater exposure to patients with NTDCs (i.e. in our sample, 88.9% of emergency physicians reported seeing 11 or more NTDCs per year, versus only 22.6% of family physicians reporting seeing 11 or more NTDCs per year). Interestingly, the response rates of emergency versus family physicians differed markedly – 41.7% and 17.6%, respectively. This is consistent with the notion that those who are interested in the content of a survey are more likely to respond. When comparing the emergency and family physicians’ answers to the NTDC clinical scenarios, the comparisons did not demonstrate statistically significant differences between the two groups, save for the greater propensity for emergency physicians to prescribe analgesics for scenario 4 (CAA). Based on these findings, we may conclude that, when assessing for potential bias due to varying levels of interest in the survey topic, there should not be any fundamental differences between the overall group of responders as compared to those who did not respond to the questionnaire.

While the above two approaches point at the comparability of our sample to the general population, the study did not reach the calculated sample size and thus caution should be exercised in generalization of the results of the participants to the larger population of Ontario family and emergency physicians. With a larger sampling frame, our sample size could have been improved. At our current response rate, 20.2%, a sampling frame of 1852 would have been needed to achieve our a priori calculated sample size of 374. Unfortunately, with the recently implemented Canadian anti-spam legislations, it proved difficult to access a larger sampling frame of our target population, as the medical associations representing our target groups were unable to distribute the survey on our behalf. Thus, we elected to have the survey distributed by a third party (Scott’s Directories) to their list of registered family and emergency physicians (n = 1012), leading to a more restricted sampling frame than would have been available in the past (i.e. prior to the implementation of the Canadian anti-spam laws). This presented another limitation to our study, as the sampling frame was not census-based and thus had some inherent
selection bias (i.e. restricted to physicians enrolled in Scott’s Directories’ e-mail list); as such, it is impossible to say with certainty that the sample was truly random. Because the sample appeared qualitatively similar to the data available from NPS (as discussed above, and as found in Table 14), the authors assumed that our sample (responses, n = 204; sampling frame, n = 1012) was a random representation of the 13445 Ontario family and emergency physicians; as such, standard parametric statistics were used in the statistical analysis. Caution may be exercised in interpreting our statistical interpretations, as non-parametric statistical methods would have been more appropriate in the event of a non-random sample.

5.6.3 Survey instrument

One of the crucial aspects of conducting population-based surveys is the design of an appropriate survey instrument. Because no survey of this kind was previously conducted, there were no previously validated questions available for our use; as such, a survey tool was independently developed by the authors and pilot-tested amongst a similar target population to evaluate and validate the survey design, level of understanding, face validity of the survey tool, and respondent burden.

The participants appeared to understand the questions clearly and the responses were considered to be reliable. This is evidenced by the fact that only 8.8% of the sample selected to prescribe an analgesic for scenario 4 (CAA), the only clinical scenario which included an NTDC patient presenting without pain. In contrast, scenarios 1, 2, and 3 all included NTDC patients presenting with severe pain, and all three scenarios led to 91.7% or greater of the sample appropriately selecting to prescribe an analgesic.

In any case scenario/vignette-based questionnaire, there may be issues associated with interpretation of the scenarios by the sample. In our survey, for each scenario the respondents were provided with a clear intra-oral photo, as well as the patient’s chief complaint and relevant clinical findings. While intra-oral photos may in particular be open to interpretation among different practitioners, the relevant clinical findings that were provided in writing for each scenario were more significant in directing the physician’s management, with the hope of minimizing the influence that varying interpretations of the intra-oral photos may have had on their choice of management. Of course, an unavoidable limitation of the use of clinical vignettes is that details regarding the patient’s dental insurance status, past medical and social history, and
socioeconomic status were not presented (i.e. real life case scenario management presents more challenge, as patients are more complex than standardized vignettes); however, such scenarios do provide us with valuable insight into decision making.263

It is not generally expected that physicians be able to establish an accurate dental diagnosis when managing patients with NTDCs (i.e. irreversible pulpitis versus localized acute apical abscess); instead, what is expected is for the physician to recognize how best to manage the patient based only on presenting signs and symptoms. This survey tool was designed to provide the respondent with these relevant signs, symptoms and key findings, which would be all that would be necessary in deciding the most appropriate management for the patient (i.e. when there is no systemic involvement, antibiotic coverage is seldom indicated; instead, interim management should include palliative measures such as provision of a short course of analgesics or even administration of an intra-oral local anaesthetic, providing the patient with pain relief until they can be seen by a dental professional).

It is apparent that a sign and symptom-based approach as described above could greatly simplify the physician’s role in providing interim management of patients with NTDCs. The corollary is that a flowchart (or guideline) specifically based on NTDC patient signs and symptoms could be of great benefit in simplifying the diagnostic process and allowing physicians to more easily and appropriately determine interim management. An example of such a flowchart is presented in Appendix B. The efficacy of guidelines is discussed in further detail below.

5.7 Strengths of this study

Having mentioned the above limitations, our study does have several strengths. To the best of the authors’ knowledge, this is the first study to look at the scenario-specific management decisions of physicians when treating patients presenting with NTDCs. Previous studies have only paid attention to the antibiotic prescribing rates of physicians in managing NTDCs, without regard for specific clinical presentations and for whether the antibiotic prescriptions were warranted.37,38 This study had a response rate in line with previous web-based surveys of physicians, and the demographic and practice characteristics of the responding sample were representative of Ontario physicians as per available National Physician Survey data. The information collected in this study helps us understand how physicians provide interim management for patients presenting with NTDCs. This study has also identified several areas
which may present opportunities for improvement in the physician management of NTDC patients, including provision of guidelines, teaching of intra-oral local anaesthetic techniques, improving collaboration between physicians and dentists, educating patients regarding the utility of antibiotics and the limited abilities of physicians to treat NTDCs, and possibly incorporating additional NTDC training in medical school curricula.

5.8 Interim management of patients with NTDCs: approaches for physicians

This section aims to expand on the NTDC management flowchart presented in Appendix B.

When a patient presents with an NTDC, physicians should first rule out any “red flags” that may indicate a potentially life-threatening condition (i.e. high fever [$>38.3^\circ C$], difficulty breathing, severe trismus, inability to swallow, elevation of the floor of mouth, etc.). Presence of any “red flags” may indicate the need for hospitalization (particularly in more extreme cases).

If there are signs or symptoms of systemic involvement, or other signs and symptoms that are precursors of serious sequelae, physicians should understand the need for antibiotics and consider their use. When there is no systemic involvement or signs of spreading infection, antibiotics are not indicated (however, as discussed below, the physician may consider a delayed antibiotic prescription). Monitoring of NTDC patients for deterioration is essential.

NTDC management by physicians should include (i) the use of interim palliative measures in order to improve the patient’s quality of life (until they are able to receive definitive dental treatment) and (ii) subsequent referral to a dental professional.

Palliative measures may include but are not limited to the following:

5.8.1 Analgesics

Analgesics are a mainstay in the interim management of dental pain. It should be noted that NSAIDs are considered to be helpful in relieving odontogenic pain, as they target the inflammation present in the tissues. The effectiveness of NSAIDs in alleviating dental pain is well established and therefore are considered to be first-line pharmacologic therapy. In cases of severe pain where NSAIDs are not expected to be sufficient to control acute pain, narcotic analgesics may be considered; however, the potential therapeutic benefits of narcotic
analgesics must be weighed against any risks of adverse effects and narcotic dependence (which fortunately are rare issues associated with short-term prescribing of narcotics, as in the case of acute dental pain).\textsuperscript{146} Recent studies have also evaluated the combined administration of ibuprofen and acetaminophen in patients who can tolerate both classes of drugs, with conclusions that this combination produces greater peak analgesia and more consistent analgesia without increasing adverse effects\textsuperscript{264-266}, thus, this may be another attractive strategy for managing emergency dental pain patients.

5.8.2 Intra-oral local anaesthesia

For dentists, intra-oral local anaesthetics are an important drug class in treating emergency pain patients, and the training of physicians in use of intra-local anaesthetics may be of benefit in the interim management of patients presenting with dental pain (i.e. this would “buy” the patient some time, especially under circumstances where there may be no access to a dental professional for a prolonged time period). As only limited armamentarium is required for administration of intra-oral local anaesthetic, it is feasible that this procedure may be incorporated into physician practices.

Skapetis et al. looked at the value of a four hour educational intervention for primary care physicians in treating traumatic dental injuries, which incorporated a module for intra-oral local anaesthetic techniques.\textsuperscript{267} After six months, the educational intervention was associated with a significant and sustained increase in proficiency and confidence to treat, especially in the use of intra-oral local anaesthesia.\textsuperscript{267} While this study pertained only to traumatic dental injuries, it is possible that this model can be applied to NTDCs as well.\textsuperscript{267}

Additionally, a survey of Australian emergency physicians regarding their preferences for topics in CME courses found that intra-oral local anaesthesia was desired as a topic by 85% of responders, lending further support to the desirability of acquiring this skillset.\textsuperscript{268}

5.8.3 Intra-oral local administration of methylprednisone

Another potential approach for interim NTDC management is the administration of localized intra-oral methylprednisone. This approach has been shown in a recent randomized clinical trial to relieve acute pulpitis pain as effectively as a pulpotomy procedure.\textsuperscript{269} The benefit of this approach is that it requires limited specialized armamentarium and is time-efficient; however,
the application is more technique sensitive than administration of intra-oral local anaesthetic and thus its applications may be more restricted. Regardless, it is an interesting approach that may be of potential benefit in the interim management of dental pain.

5.8.4  Delayed prescriptions of antibiotics

As discussed above, antibiotics do not relieve endodontic pain, and systemic involvement is the only true indication for an antibiotic prescription for patients with NTDCs. When physicians feel it is safe not to prescribe antibiotics immediately, prescribing none with advice to return if symptoms worsen (prior to seeing a dental professional for definitive treatment) is an effective and prudent approach. However, in cases where the patient presents with no immediate indication for an antibiotic but where there is fear of future spreading infection or impending systemic involvement, the physician may consider prescribing a delayed prescription of an antibiotic (i.e. providing the prescription but advising the patient to delay its use in the hope that symptoms resolve or do not progress prior to receiving definitive treatment).

A Cochrane Review which looked at delayed antibiotics for symptoms and complications of acute respiratory tract infections found that delayed prescribing resulted in 32% of patients using antibiotics compared to 93% of patients who received immediate prescriptions (however, not prescribing antibiotics at all resulted in the least antibiotic usage – 14% of patients). Patient satisfaction was only slightly reduced in the delayed antibiotic group (87% satisfied) compared to the immediate antibiotic group (92% satisfied). As such, delayed antibiotics appear to be an effective approach to reducing the inappropriate use of antibiotics. We believe that this approach may be applied to patients presenting with NTDCs.

5.9  Applicability of this study’s findings and future directions

Physicians faced with patients requiring treatment for an NTDC should be able to assess the patient’s symptoms and provide the patient with “best evidence” care until a visit with a dentist can be scheduled. When this is not done, there is a strong possibility that the patient may receive inappropriate treatment, especially the unnecessary administration of an antibiotic. This adds to the global rise in antibiotic-resistant infections and the accompanying health-related and economic-related result that ensues.
The findings of this study may be of interest to medical regulatory bodies—i.e. College of Physicians and Surgeons of Ontario, Royal College of Physicians and Surgeons of Canada, College of Family Physicians of Canada, Canadian Association of Emergency Physicians—with the intent of altering the current practices used by physicians for the management of patients with NTDCs. As well, incorporation of additional dental knowledge into medical school curricula may be one approach for effecting change in current practices. Our results may have relevance throughout North America because of the comparability between Canadian and American medical education, as reflected in the Liaison Committee on Medical Education (LCME)’s accreditation standards for Canadian and American undergraduate and post-graduate medical programs.

A variety of practice-altering interventions could be implemented which may subsequently curb the rise in antibiotic-resistant infections if they result in a more judicious use of antibiotics. Studies show that significant changes in prescribing habits may reduce the rate at which new antimicrobial resistance accumulates. Reducing antibiotic prescribing at the general practice level results in a reduced incidence of resistance in the local community, demonstrating that modification in prescribing habits of individual practitioners can influence the patterns of resistance. A report by Conly, published in the CMAJ in 2002, added further support to this possibility by stating that there was an adjusted decline of 11% in total antibiotic prescriptions (21% in beta-lactamase related prescriptions) in Canada between 1995 and 2000, on the heels of a national consensus conference on the unnecessary prescribing of antibiotics held in 1997. These results show that systematic efforts to reduce unnecessary prescribing can have an impact.

5.9.1 Supplementing physician knowledge regarding NTDCs

While little is known regarding how management outcomes would be affected via enhanced NTDC training, studies have shown that physicians who receive dental-related training display an improved ability to diagnose oral problems and make more proper referrals to dental professionals. Skapetis et al. are of the opinion that, given the crowded nature of undergraduate medical curricula and that the practical management of NTDCs is more relevant after graduation, an effective approach to address dental-related education gaps could be through specifically designed CME courses. Specifically, Skapetis et al. relate that the most effective CME would contain multiple instructional techniques (with skill-based workshops), use multiple media, and involve multiple educational exposures for reinforcement.
One interesting finding from our survey is that, while we did find an association between more hours of NTDC training and greater overall comfort in treating NTDCs, we did not find an association between more hours of NTDC training and lower overprescribing index scores. Specifically, emergency physicians, when compared to family physicians, reported receiving more hours of NTDC training and reported greater comfort in management of NTDCs, but their management did not significantly differ from that of family physicians. Accordingly, it is not clear whether supplementing physician didactic knowledge regarding NTDCs would derive a benefit in terms of reducing inappropriate antibiotic prescribing (i.e. other practice/patient factors may play a more influential role in the decision-making process). In other words, it is unclear whether having satisfactory knowledge in itself leads to correct implementation of this knowledge. For example, we have seen that dentists—who do in fact receive specific training regarding NTDCs—are themselves prone to prescribing antibiotics in clinical scenarios in which they are not warranted.\textsuperscript{66,199-201,205-207,210,213,216} While this study tried to address this gap by asking physicians about specific practice and patient pressures which may affect their prescribing decisions, future research should aim to further understand why a gap between knowledge acquisition and knowledge implementation may exist.

5.9.2 Improving practice habits: interventional approaches
As the issue of antibiotic overprescribing is multidimensional in nature, a variety of interventions have been designed to improve antibiotic prescribing by health care professionals.\textsuperscript{75} Interventions may include dissemination of guidelines to providers, educational meetings and lectures, audit and feedback, clinical decision support systems, mass media campaigns, and delayed prescriptions.\textsuperscript{75} The following section reviews the efficacy of several of these potential interventions.

5.9.2.1 Practice guidelines
Practice guidelines are controversial. While guidelines are seen as helpful in the provision of continuing education and as a support in daily clinical decision making, the most important barrier to successful implementation of clinical practice guidelines is the fear of practitioners that guidelines will reduce their professional autonomy.\textsuperscript{272} In fact, in a survey of dentists, only about 50% supported the development and implementation of clinical guidelines.\textsuperscript{272}

There are various barriers to the use of guidelines, even when guidelines are available.\textsuperscript{273} These barriers often act collectively to prevent adherence to available guidelines, and barriers may
include: lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, the inertia of previous practice, and external barriers.\textsuperscript{273}

Furthermore, it has been shown that guidelines issued to family physicians, as a standalone initiative, may not be effective unless they are specific, uncontroversial, evidence based, and require no change to existing routine.\textsuperscript{274,275} Largely, guidelines are more effective when linked with educational initiatives.\textsuperscript{276}

Nevertheless, clear guidelines and prescribing policies should be in place as a reference standard to curtail inappropriate antibiotic prescribing practices. Palmer et al. recommend that health care professionals need simple, clear, and practical guidelines on when and what to prescribe.\textsuperscript{184}

Ma et al. assessed the effect of guidelines written for physicians and patients for emergency department management of dental emergencies.\textsuperscript{277} Their guidelines emphasized appropriate dental clinic referrals and the use of NSAIDs. The study found that during a one year period (which was retrospectively compared to the one year period prior to guideline implementation), implementation of these guidelines led to a significant decrease in visits for dental-related problems, a decrease in the proportion of patients with return visits, and a decrease in the proportion of patients receiving a narcotic prescription.\textsuperscript{277} They concluded that guidelines can be effective in reducing narcotic prescribing and return visits.\textsuperscript{277} It is possible that guidelines may have a similar effect in reducing antibiotic prescribing.

5.9.2.2 Audit approaches

An approach that has been advocated in the past to improve prescribing habits is through the use of a professional audit. One study done in the United Kingdom by Palmer et al. looked at whether audit, using a combination of guidelines and an educational component with feedback, could improve antibiotic prescribing among practicing general dentists.\textsuperscript{275} Information was collected over an initial six-week period from 175 dentists regarding their current antibiotic prescribing practices. The information collected included antibiotic regimens, clinically presenting signs and symptoms, medical history, and any other reasons for prescribing. The dentists then had an audit which included an educational component and the issuing of guidelines. Following the audit, dentists’ antibiotic prescribing practices were collected for another six-week period and was compared with the pre-audit data. Results showed that antibiotic prescriptions reduced by 42.5\% in the post-audit period (the number of prescriptions
reduced from 2316 to 1330 after the audit), with a concomitant reduction in the number of prescriptions that did not conform to issued guidelines. This suggests that audit, combined with an educational initiative and guidelines, may encourage more judicious usage of antibiotics. Another study by Steed and Gibson found similar effects of audit on dentist prescribing patterns, with audit leading to a reduction in prescription writing by approximately 50%.

5.9.2.3 Educational outreach visits

Educational outreach visits have been advocated as an approach to improve prescribing habits among practicing health professionals. A study done by Seager et al. looked to assess the effect of educational outreach visits on antibiotic prescribing for acute dental pain among general dentists. In this randomized controlled trial, 3 groups of dentists were allocated: the first group acted as a control, the 2nd group received written guidelines for prescribing antibiotics, and the 3rd group received the same guidelines as the 2nd group and a visit from a trained pharmacist. The number of antibiotics prescribed to patients with dental pain and the number of inappropriate antibiotic prescriptions (i.e. no signs of spreading infection) were measured after the educational outreach intervention. Compared to the control group and the group which only received guidelines, the 3rd group—which received the guidelines and an educational visit from the trained pharmacist—issued significantly fewer prescriptions to patients with dental pain and significantly fewer inappropriate prescriptions. Interestingly, prescribing practices between the control and guideline-only groups were not significantly different. As such, it was concluded that strategies based upon educational outreach visits might be successful in improving antibiotic prescribing practices among dentists.

5.9.2.4 Patient education

An often overlooked aspect of NTDC patient management is that it is likely that many patients are unaware of the limited capabilities of most EDs, and thus informing patients of what services are offered can help redistribute them to providers who can offer appropriate care (without such knowledge, patients frequently return for episodic symptom relief). Accordingly, educating patients and altering their expectations may be a valuable tool in effecting change in this regard. For example, patients could be educated that antibiotics are generally of no help for NTDCs unless systemic signs present, and that antibiotics do not directly relieve dental pain. As well, patients could be educated that physicians will not be able to provide definitive care for NTDCs, and, as such, any care received will only be interim and palliative in nature.
5.9.2.5 Which interventions should future policy focus on?

As evidenced in the preceding sections, there are a number of possible interventions which may act to curtail inappropriate prescribing habits; however, all of the above-mentioned interventions seem to have at least some efficacy depending on which study the reader decides to focus on. Are we able to identify a single approach that may be most effective?

Davis et al., in their systematic review of interventions among physicians in changing clinical practice, suggested that some approaches may be more effective than others. They concluded that audit with feedback and guidelines were less effective interventions in effecting change and that CME courses had little impact on improving professional practice. Instead, effective strategies were found to be: reminders, patient-mediated interventions, outreach visits, opinion leaders, and multifaceted activities.

On the other hand, Bazaldua et al. suggested that specific approaches are not more effective than others. They were of the opinion that the use of multiple methods in combination facilitates the successful implementation of pharmacotherapy knowledge, with little evidence that one specific method is more effective than another in improving knowledge.

Finally, Arnold and Straus’ Cochrane Review of interventions to improve antibiotic prescribing practices in ambulatory care reviewed 39 studies examining the effect of printed educational materials for physicians, audit and feedback, educational meetings, educational outreach visits, financial and healthcare system changes, physician reminders, patient-based interventions and multi-faceted interventions. The use of printed educational materials or audit and feedback alone resulted in no to only small changes in prescribing habits. Interactive educational meetings appeared to be more effective than didactic lectures, while educational outreach visits and physician reminders produced mixed results. Patient-based interventions, particularly the use of delayed prescriptions for infections for which antibiotics were not immediately indicated effectively reduced antibiotic use by patients. Overall, multi-faceted interventions combining physician, patient and public education in a variety of venues and formats were the most successful in reducing antibiotic prescribing for inappropriate indications.

In conclusion, there is no clear answer as to whether one particular interventional approach is more effective than another. An array of possible strategies is available, some of which do appear to be more promising than others, depending on which study the reader focuses on.
Multi-faceted approaches appear to be the most effective means of effecting change, and thus future interventions should focus on more than one modality in trying to effect change (i.e. some combination of guidelines, use of delayed prescriptions, along with educational outreach, patient education, and/or audit approaches may be an effective strategy). The need for multi-faceted interventions is consistent with the reality that physicians in the community prescribe antibiotics inappropriately for many different reasons, and thus one intervention method alone cannot be recommended to correct a complex problem. This is consistent with findings in the systematic review of Oxman et al. of 102 trials of interventions to improve professional practice among physicians. They concluded that interventions which change physician-prescribing behaviours are complex and that there are “no magic bullets.” The value of devoting similar resources to educating physicians about prescribing for dental conditions should be balanced against other efforts to make dental care more accessible and acceptable to the public and thereby minimize attendances in those settings where they are unlikely to see a dentist.
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129


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Appendices

Appendix A. Survey instrument.

NTDE - Final

Introduction and Consent to Participate
Dear Colleague,

My name is Dr. Ralph Dana and I am a 2nd year resident in the Endodontic MSc. Specialty Program in the Faculty of Dentistry, University of Toronto.

I would like to invite you to participate in this study assessing the management of non-traumatic dental emergencies ("NTDEs") by physicians engaged in Emergency Medicine and Family Practice in Ontario. Specifically, emergencies that relate to facial pain, jaw pain, tooth pain, and the signs and symptoms of dental infection. Information gained from this study will be used to determine the comfort level of physicians that have to address such emergencies, the protocols that are used, and the success of those protocols in resolving the complaint voiced by the patient. This information may be used to make revisions in the training program of medical interns to ensure that the choices made in treating these emergencies reflect "best evidence."

The survey will take less than 10 minutes of your time to complete. It can however have long term impact by enhancing physician knowledge of dental related problems and, through that, improving patient care. There is no personal cost nor is reimbursement available for your participation in the survey, and participation is completely voluntary. The physicians selected for participation represent a broad demographic distribution in Ontario and reflect a broad age range.

Privacy will be respected, so you can be assured that we will fastidiously maintain confidentiality and the anonymity of those who participate. The ID number assigned to each form will only be used to log respondents and no information disclosing participant's identity will be released or printed. Responses will not be linked to a name during data collection, nor will any form of identity be used in publications or presentations that arise from the study. There is no need to include any personal information with any of the responses and understand that withdrawal from the study can be made at any time by simply clicking "exit survey" on your screen.

When you click the "yes" button to begin the survey, you give consent to allow use of this survey to compile data, use the data to draft recommendations, and publish the accrued information in a health related journal. The study has received approval from the Research Ethics Board of the University of Toronto.

If you have any questions about your rights or responsibilities as a participant, please contact the Ethics Office at ethics.review@utoronto.ca or call (416) 946-3273. I can be reached at r.dana@mail.utoronto.ca should any additional information regarding this survey be required.

Thank you for your time. It is only through the active participation of responsible health providers that research of this nature is possible.

Sincerely,

Ralph Dana, BSc, DDS
MSc Candidate (Endodontics)
University of Toronto, Faculty of Dentistry
Room 348, 124 Edward Street, Toronto, ON, M5G 1G6
Phone: (416) 979-4911 ext: 4401
Email: r.dana@mail.utoronto.ca

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Dr. Karl Iglar, Post Graduate Program Director, Family and Community Medicine, Faculty of Medicine
Dr. Carlos Quiñones, Assistant Professor, Discipline of Dental Public Health, Faculty of Dentistry
Dr. Calvin Torneck, Professor Emeritus, Discipline of Endodontics, Faculty of Dentistry
I agree to participate in this study. *
  - Yes
  - No

Please select from one of the following: *
  - I would like the investigator of this study to contact me in order to discuss this survey before I agree to proceed.
  - I do not want to participate.

Please enter your e-mail address or phone number in the box below and we will contact you. *

(untitled)

Do you direct or provide patient care? *
  - Yes
  - No

Please select the category which best describes your present employment: *
  - Active practitioner
  - Retired practitioner
  - Academia/research -- with part-time practice
  - Academia/research -- with no practice involvement
  - Other (required) *

(untitled)

There are two broad types of dental emergencies that may present to physicians in practice:
(1) traumatic dental emergencies
(2) non-traumatic dental emergencies (e.g. facial pain, jaw pain, tooth pain, and dental infections)

In the following section, you are provided with four clinical scenarios involving patients presenting with non-traumatic dental emergencies ("NTDEs"). For each of the four cases, please read the short abstract and answer the subsequent questions regarding your management of the patient.

Clinical Scenario 1 (of 4)
A 35-year-old male with a non-contributory medical history presents to your clinic on an emergency basis. He does not have immediate access to a dentist.

Relevant history:
- He complains of a severe toothache, which began two days ago.
- He is unable to localize which tooth is bothering him but feels the pain emanates from his lower left jaw.
- He describes the pain as a constant throbbing which is exacerbated by cold and hot drinks.
- He has difficulty sleeping as a result of the pain.

Extraoral exam:
- No abnormalities or swelling of the jaw.
- No systemic involvement detected.

Intraoral exam:
- He has several large dental restorations.
- No obvious abnormalities or pathosis detected.
Understanding that the patient is in pain and cannot be seen by a dentist immediately, please select which of the following would apply in your management of this patient prior to referral to a dentist: (check all that apply)

☐ Analgesic
☐ Antibiotic
☐ No management besides referral to a dentist
☐ Other (please specify) 

You've elected to prescribe an analgesic for this patient.

Which analgesic would be your first choice?

Analgesic

Acetaminophen
Acetylsalicylic acid (ASA)
Celecoxib
Combination acetaminophen/ASA with codeine
Combination acetaminophen/ASA with oxycodone
Codeine
Diclofenac
Ibuprofen
Ketorolac
Naproxen
Oxycodone
Tramadol
Other

Please specify which "other" analgesic you'd prescribe.

Strength

☐ mg

Strength

8 mg codeine (e.g. Tylenol #1)
15 mg codeine (e.g. Tylenol #2)
30 mg codeine (e.g. Tylenol #3)
60 mg codeine (e.g. Tylenol #4)

Strength

2.5 mg oxycodone (e.g. Percocet-Demi)
5 mg oxycodone (e.g. Percocet, Percodan)
Frequency
- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration
- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days
You've elected to prescribe an antibiotic for this patient.

Which antibiotic would be your first choice?

Antibiotic

- Amoxicillin
- Amoxicillin & clavulanic acid
- Azithromycin
- Cephalosporin
- Ciprofloxacin
- Clarithromycin
- Clindamycin
- Erythromycin
- Metronidazole
- Penicillin V
- Tetracycline
- Other

Please specify which "other" antibiotic you'd prescribe.

Dosage

mg

Frequency

- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration

- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days

Clinical Scenario 2 (of 4)
A 40-year-old female with a non-contributory medical history presents to your clinic on an emergency basis. She does not have immediate access to a dentist.

Relevant history:
- She complains of a severe toothache, which she reports started bothering her yesterday.
- She reports that she has a constant dull pain which she can localize to the first premolar in her upper right jaw.
- She says that the tooth “feels high and loose.”
- She reports swelling began in the area adjacent to this tooth overnight.
- There is no history of pain to hot or cold, but there is pain on biting or when tapping the tooth with her finger.

Extraoral exam:
- No abnormalities or swelling are detected.
- No systemic involvement detected.

Intraoral exam:
- Localized and fluctuant swelling on gingival mucosa adjacent to the tooth the patient complains about.

Intraoral image of patient in Scenario 2.
Understanding that the patient is in pain and cannot be seen by a dentist immediately, please select which of the following would apply in your management of this patient prior to referral to a dentist: (check all that apply)

- [ ] Analgesic
- [ ] Antibiotic
- [ ] No management besides referral to a dentist
- [ ] Other (please specify)

You’ve elected to prescribe an analgesic for this patient.

Which analgesic would be your first choice?

Analgesic

- Acetaminophen
- Acetylsalicylic acid (ASA)
- Celecoxib
- Combination acetaminophen/ASA with codeine
- Combination acetaminophen/ASA with oxycodone
- Codeine
- Diclofenac
- Ibuprofen
- Ketorolac
- Naproxen
- Oxycodone
- Tramadol
- Other

Please specify which “other” analgesic you’d prescribe.

Strength

- mg

Strength

- 8 mg codeine (e.g. Tylenol #1)
- 15 mg codeine (e.g. Tylenol #2)
- 30 mg codeine (e.g. Tylenol #3)
- 60 mg codeine (e.g. Tylenol #4)

Strength

- 2.5 mg oxycodone (e.g. Percocet-Demi)
- 5 mg oxycodone (e.g. Percocet, Percodan)
Frequency
- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration
- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days
You've elected to prescribe an antibiotic for this patient.

Which antibiotic would be your first choice?

Antibiotic

- Amoxicillin
- Amoxicillin & clavulanic acid
- Azithromycin
- Cephalexin
- Ciprofloxacin
- Clarithromycin
- Clindamycin
- Erythromycin
- Metronidazole
- Penicillin V
- Tetracycline
- Other

Please specify which *other* antibiotic you'd prescribe.

Dosage

mg

Frequency

- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration

- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days

Clinical Scenario 3 (of 4)
A 55-year-old male with a non-contributory medical history presents to your clinic on an emergency basis. He does not have immediate access to a dentist.

Relevant history:
- He complains of a severe toothache and reports feeling symptoms for the first time yesterday.
- He feels a constant ache in the left mandibular first molar.
- He reports there is a painful swelling on the buccal aspect of his tooth.
- He cannot eat on his left side.
- He feels he has a fever.

Extraoral exam:
- Slight extraoral facial swelling overlying his left jaw.
- Lymphadenopathy of his left submandibular region.
- Body temperature recorded orally on examination to be 38.5°C.

Intraoral exam:
- Warm, fluctuant, and painful gingival swelling adjacent to the tooth the patient complains about.
Understanding that the patient is in pain and cannot be seen by a dentist immediately, please select which of the following would apply in your management of this patient prior to referral to a dentist: (check all that apply)

- Analgesic
- Antibiotic
- No management besides referral to a dentist
- Other (please specify)

You've elected to prescribe an analgesic for this patient. Which analgesic would be your first choice?

Analgesic

Acetaminophen
Acetylsalicylic acid (ASA)
Celecoxib
Combination acetaminophen/ASA with codeine
Combination acetaminophen/ASA with oxycodone
Codeine
Diclofenac
Ibuprofen
Ketorolac
Naproxen
Oxycodone
Tramadol
Other

Please specify which "other" analgesic you'd prescribe.

Strength

mg

Strength

8 mg codeine (e.g. Tylenol #1)
15 mg codeine (e.g. Tylenol #2)
30 mg codeine (e.g. Tylenol #3)
60 mg codeine (e.g. Tylenol #4)

Strength

2.5 mg oxycodone (e.g. Percocet-Demi)
5 mg oxycodone (e.g. Percocet, Percodan)
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<th>Frequency</th>
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<td>Every 12 hours</td>
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<th>Duration</th>
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<td>1 to 2 days</td>
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<td>3 to 4 days</td>
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<tr>
<td>5 to 7 days</td>
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<tr>
<td>8 or more days</td>
</tr>
</tbody>
</table>
You've elected to prescribe an antibiotic for this patient.

Which antibiotic would be your first choice?

Antibiotic

- Amoxicillin
- Amoxicillin & clavulanic acid
- Azithromycin
- Cephalosporin
- Ciprofloxacin
- Clarithromycin
- Clindamycin
- Erythromycin
- Metronidazole
- Penicillin V
- Tetracycline
- Other

Please specify which "other" antibiotic you'd prescribe.

Dosage

- mg

Frequency

- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration

- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days

Clinical Scenario 4 (of 4)
A 60-year-old male with a non-contributory medical history presents to your clinic on an emergency basis. He does not have immediate access to a dentist.

Relevant history:
- He is concerned about a recurrent “gumboil” that appeared near his first premolar in his upper right jaw.
- He noticed this bump for the first time 4 months ago.
- He reports that this bump has come and gone several times over the past 4 months.
- There has been no pain in the area.
- He occasionally sees pus and blood discharging from this “boil,” particularly if he applies pressure to the area.

Extraoral exam:
- No abnormalities or swellings are detected.
- No systemic involvement detected.

Intraoral exam:
- Pustule on the buccal mucosa opposite the maxillary right first premolar.
- Slight discomfort and a purulent discharge when pressure is placed on the “gumboil.”

Intraoral image of patient in Scenario 4.
Understanding that the patient cannot be seen by a dentist immediately, please select which of the following would apply in your management of this patient prior to referral to a dentist: (check all that apply) *

- Analgesic
- Antibiotic
- No management besides referral to a dentist
- Other (please specify) 

You've elected to prescribe an analgesic for this patient. Which analgesic would be your first choice?

Analgesic

- Acetaminophen
- Acetylsalicylic acid (ASA)
- Celecoxib
- Combination acetaminophen/ASA with codeine
- Combination acetaminophen/ASA with oxycodone
- Codeine
- Diclofenac
- Ibuprofen
- Ketorolac
- Naproxen
- Oxycodone
- Tramadol
- Other

Please specify which "other" analgesic you'd prescribe.

Strength


Strength

- 8 mg codeine (e.g. Tylenol #1)
- 15 mg codeine (e.g. Tylenol #2)
- 30 mg codeine (e.g. Tylenol #3)
- 60 mg codeine (e.g. Tylenol #4)

Strength

- 2.5 mg oxycodone (e.g. Percocet-Demi)
- 5 mg oxycodone (e.g. Percocet, Percodan)
<table>
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<tr>
<th>Frequency</th>
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<tbody>
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<td>Every 4 hours</td>
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<td>Every 6 hours</td>
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<td>Every 8 hours</td>
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<td>Every 12 hours</td>
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<tr>
<th>Duration</th>
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<tr>
<td>1 to 2 days</td>
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<tr>
<td>3 to 4 days</td>
</tr>
<tr>
<td>5 to 7 days</td>
</tr>
<tr>
<td>8 or more days</td>
</tr>
</tbody>
</table>
You've elected to prescribe an antibiotic for this patient.

Which antibiotic would be your first choice?

Antibiotic

- Amoxicillin
- Amoxicillin & clavulanic acid
- Azithromycin
- Cephalosporin
- Ciprofloxacin
- Clarithromycin
- Clindamycin
- Erythromycin
- Metronidazole
- Penicillin V
- Tetracycline
- Other

Please specify which "other" antibiotic you'd prescribe.

Dosage

mg

Frequency

- Every 4 hours
- Every 6 hours
- Every 8 hours
- Every 12 hours
- Every 24 hours

Duration

- 1 to 2 days
- 3 to 4 days
- 5 to 7 days
- 8 or more days

(untitled)
Which of the following are indications for prescribing an antibiotic when dealing with a dental emergency?

Please check all that apply.
- Pyrexia
- Chills, rigors
- Localized intraoral swelling
- Diffuse swelling / cellulitis
- Draining intraoral sinus tract
- Severe trismus
- Tooth pain
- None of the above

**Experience with Dental Emergencies**

Please estimate how many NTDEs (i.e. dental pain, abscesses, etc...) you see in an average year. *
- Zero
- 1 to 2
- 3 to 5
- 6 to 10
- 11 to 20
- More than 20

**How would you rate your comfort level in the following aspects of managing non-traumatic dental emergencies ("NTDEs")?** *

<table>
<thead>
<tr>
<th></th>
<th>Very uncomfortable</th>
<th>Uncomfortable</th>
<th>Comfortable</th>
<th>Very comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obtaining a dental history (i.e. patient chief complaint and interview)</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Performing an extra-oral exam (i.e. assessing asymmetries, lymph nodes, ...)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performing an intra-oral exam (i.e. assessing oral hard and soft tissues)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescribing appropriate analgesics for NTDEs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescribing appropriate antibiotics for NTDEs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall comfort in managing patients with NTDEs (i.e. pain and/or infections)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Do you typically use a flowsheet or checklist for assessing and managing dental emergencies?

- Yes
- No

When prescribing an antibiotic for a patient with an NTDE, is the patient contacted or re-examined after the period of antibiotic administration?

- Never
- Some of the time
- Most of the time
- Always

When referring a patient to a dentist, to which type of clinic do you mostly refer? *

- Private practice
- Hospital-based dental clinic
- Public health dental clinic
- University-based dental clinic
- Other (please specify)

Training and Relations

Please estimate the number of hours of training you received regarding dental disease, dental pain, and dental emergency treatment during your: *

<table>
<thead>
<tr>
<th>Training Type</th>
<th>Zero</th>
<th>1 to 5</th>
<th>6 to 10</th>
<th>11 to 20</th>
<th>20 or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate medical training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-graduate (residency/fellowship) medical training</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuing Medical Education (CME) course(s)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Please indicate whether you agree or disagree with the following statements:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>My medical training adequately prepared me to treat dental emergencies (i.e. pain, infection).</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>More training should be incorporated into medical school curricula regarding treating dental emergencies.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>I have adequate training in administering an intra-oral local anesthetic for temporary pain relief.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>I have adequate training in incision and drainage of a localized intra-oral swelling.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>There are management guidelines or protocols available to me (issued by medical or dental associations/groups) on treating dental emergencies.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>There are dental colleagues available with whom I feel comfortable communicating and collaborating with.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>There are dentists available to whom I can refer patients without difficulty.</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
</tbody>
</table>

Which of the following have been your greatest source of information regarding treating dental emergencies?

* Please check all that apply.
- Medical school
- Residency or fellowship training
- Journal articles
- Textbooks
- Medical colleagues
- Dental colleagues
- CME courses
- Internet browsing (i.e. UpToDate, Trip Database, etc...)
- Clinical experience
- Other (please specify)

How likely are you to take a course covering topics related to dental pain / emergencies within the next 12 months?

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Very unlikely</th>
<th>Unlikely</th>
<th>Likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Please Specify)</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
</tbody>
</table>
Which of the following reasons describe why you are unlikely to take a course of this nature?

Please check all that apply.

☐ Lack of relevance to my practice
☐ My knowledge on this subject is adequate
☐ No such course available (lack of opportunity)
☐ Time away from practice
☐ Cost of CME activities
☐ Other (please specify)

Work Environment

How likely are each of the following to influence your decision to prescribe an antibiotic for a patient presenting with a dental emergency, when an antibiotic is not indicated by your clinical findings (i.e. no systemic involvement, no signs of infection)? 

<table>
<thead>
<tr>
<th>Reason</th>
<th>Very unlikely</th>
<th>Unlikely</th>
<th>Likely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited time to spend with the patient.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Limited willingness to explain to the patient that an antibiotic is not needed.</td>
<td></td>
<td></td>
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<tr>
<td>Fear of medicolegal problems if the patient deteriorates.</td>
<td></td>
<td></td>
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<tr>
<td>Not wanting to be perceived as doing nothing for the patient.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unsure of diagnosis / etiology of patient’s pain.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Please indicate whether you agree or disagree with the following statements: 

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most patients presenting with dental pain expect a prescription for an antibiotic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am more likely to prescribe an antibiotic when a patient requests or demands one.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Withholding an antibiotic from a patient who specifically requests an antibiotic will impact whether this patient continues with my practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Which best describes your day-to-day practice?
- All family medicine
- Mostly family practice, some emergency medicine
- Half and half
- Mostly emergency medicine, some family medicine
- All emergency medicine

Which of the following best describes your residency training? *
- Family medicine
- CCFP-EM program
- FRCPC-EM program
- Other (please specify)

Which of the following best describes your primary work setting? *
- Private office/clinic
- Community clinic/health centre
- Free standing walk-in clinic
- Emergency department
- Nursing home
- Community hospital
- Academia or research
- Other work setting

Please indicate how often you are involved in the clinical practice of medicine? *
- Full time (≥32 hours per week)
- Part-Time (<32 hours/week)
Please estimate the number of patients you see in a TYPICAL WEEK.

- Less than 25
- 25 to 50
- 51 to 75
- 76 to 100
- 101 to 125
- 126 to 150
- 151 to 175
- 178 to 200
- More than 200

**Demographics**

Please select the year of completion of your MOST RECENT post-graduate medical training (i.e. residency/internship).

- Prior to 1960s
- 1960s
- 1970s
- 1980s
- 1990s
- 2000s
- 2010s
- Presently in post-graduate program

**Where did you complete your MOST recent post-graduate medical training?**

- Canada--Ontario
- Canada--Other province
- United States
- Other (please specify)

**Where did you complete your undergraduate medical training?**

- Canada--Ontario
- Canada--Other province
- United States
- Other (please specify)
In which province do you practice? *
- Alberta
- British Columbia
- Manitoba
- New Brunswick
- Newfoundland & Labrador
- Northwest Territories
- Nova Scotia
- Nunavut
- Ontario
- Prince Edward Island
- Quebec
- Saskatchewan
- Yukon

With respect to your MAIN patient care/practice setting, please describe the population PRIMARILY served by you in your practice. *
- Urban/suburban
- Small town
- Rural
- Geographically isolated/remote
- Cannot identify a primary geographic population

Please select your age category. *
- 34 and under
- 35-44
- 45-54
- 55-64
- 65 and over

Please select your gender. *
- Male
- Female

Thank You!
If you have any other comments or remarks about this survey, please feel free to enter them for the authors in the box below.

Thank You!

Thank you for completing our survey. Your response is very important to us.
Appendix B. Flowchart: sign/symptom-based approach for NTDCs.

This simplified approach does not account for the possible variety of dental symptoms and does not attempt to differentiate between different causes of dental pain (i.e. irreversible pulpitis, localized acute apical abscess, etc.), as this is generally not necessary for the physician to establish. Instead, this approach focuses on simplifying the physician’s interim management of this patient, prior to the patient being able to seek definitive treatment with a dental professional. It should be noted that all patients presenting with NTDCs should be referred to a dental professional for diagnosis and definitive treatment; symptoms may ebb and flow over time, but, without definitive treatment, recurrences (and possibly repeat visits) are inevitable.

The suggested analgesic regimens are based on those recommended by Haas, and the suggested antibiotic regimens are based on those recommended by the American Association of Endodontists.

Monitor for deterioration

If “red flags” indicating potentially life-threatening condition (i.e. high fever, difficulty breathing, severe trismus, inability to swallow, etc.), refer to emergency department / oral surgeon

Always refer to a dental professional for diagnosis and definitive treatment
*Antibiotics:

- Penicillin VK 250-500 mg qid x 5-7 days, or Amoxicillin 250-500 mg tid x 5-7 days
- If allergic to penicillins: Clindamycin 150-300 mg qid x 5-7 days
- Other antibiotics may be considered (e.g. clavulin, clarithromycin, azithromycin)
- A loading dose (usual 2x of the regular dose) should be considered

**Analgesics:

- If mild-to-moderate pain: prescribe acetaminophen
- When 1000 mg of acetaminophen is insufficient (i.e. for moderate-to-severe pain):
  - **If no contraindication to NSAIDs:**
    - Prescribe NSAID
    - Then, if more analgesia is required (i.e. for severe pain):
      - Add codeine to NSAID, acetaminophen, or ASA, or
      - Add oxycodone with acetaminophen or ASA
  - **If NSAIDs contraindicated:**
    - Add codeine to acetaminophen
    - Then, if more analgesia is required, add oxycodone with acetaminophen