# "EVALUATING THE EFFECT OF A SUBSIDY FREEZE ON DENTAL HEALTH UTILIZATION IN NEWFOUNDLAND AND LABRADOR"

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Title Page

"Evaluating the effect of a subsidy freeze on dental health utilization in Newfoundland and Labrador"

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## ABSTRACT

In 1995, fees for dental services under the Dental Health Plan (DHP) in Newfoundland and Labrador were frozen. The purpose of this thesis was to evaluate the effect of the subsidy freeze on dental health utilization in children ages 12 and under from 1996 to 2005. Utilization was determined by measuring the durations between dental maintenance visits. In addition, the effect of persons per dentists, gender, socioeconomic status, fee differential, fee differential linked with socioeconomic status, Census Division (CD), age and year on durations were studied.

Over the 10-year observation period, there were longer average durations between maintenance visits. The number of persons per dentist, socioeconomic status, fee differential linked with socioeconomic status, the age of the child, CD and year were statistically significantly associated with the length of time between maintenance visits.

To evaluate the effect of longer durations on oral health, the proportion of maintenance visits ending in caries and/or emergency visits were measured across socio-economic quintiles for each year of the observation period. The results showed no increase in the incidences of caries and a slight increase in incidences of emergency visits in the lower socioeconomic quintiles.

The frozen subsidy did lead to a decline in utilization as subjects were waiting for longer durations between maintenance visits. However, in most cases longer durations did not result in adverse dental outcomes.

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## List of Abbreviations

Dental Health Plan (DHP)

Newfoundland and Labrador Department of Health and Community Services (NL DoHCS)

Newfoundland and Labrador Dental Association (NLDA)

Decayed/missing/filled teeth (DMFT)

Personal identification number (PIN)

Socio-economic status (SES)

Census Division (CD)

Dissemination Area (DA)

## Appendixes

1. Dentists by community and Census Division
2. Communities within a Census Division
3. Population projections and dental ratio

## 1.0 Introduction

This portion of the thesis will examine my reasons for choosing this particular research area. A history of the Dental Health Plan (DHP) will be provided along with previous research involving the DHP. An overview of dental health care coverage for each Canadian province and territory is provided. Finally, the purpose and the objectives of the thesis will be discussed.

## 1.1 Research Interest

There has been limited research on dental health within the province of Newfoundland and Labrador, specifically the impact of removing dental coverage for children. The Newfoundland and Labrador Department of Health and Community Services (NL DoHCS) recognized this absence in dental health research and created a research initiative to assess the current provincial Dental Health Plan (DHP). Drops in DHP utilization rates acted as a stimulus to prompt NL DoCHS to explore reasons for the decline. Additionally, the Newfoundland and Labrador Dental Association (NLDA) were interested in the project and were willing to assist as they too recognized this lack of dental health research. As dental health research is so limited, this study will be beneficial to the NL DoCHS, NLDA, and Canadian Dental Association (CDA) and contribute more generally to the literature on dental health utilization patterns.

The DHP provides coverage for all children under the age of 13; coverage consists of a biannual check up and an annual cleaning. The policy is important as it promotes oral health care through subsidization and encourages children to receive oral health care at cost. The DHP is designed to be affordable to all residents of

Newfoundland and Labrador. In recent years, the DHP has experienced a decline in utilization. The research project will assess the impact the decline in utilization has had on the oral health status of children within our province and identify potential factors associated with the usage decline of the DHP.

### 1.2 Introduction to DHP

Government subsidies for dental health care are becoming increasingly more important to Canadian children, especially those raised in low-income households. The cost of visiting the dentist has increased considerably, making it more challenging for low-income families to access dental services (9). The DHP is designed to provide the opportunity for each child to receive dental treatment. The DHP has undergone several policy changes since it was first implemented in the early 1950's. Originally, the DHP was designed for children residing in orphanages, and schools for the blind and deaf. In 1960, the Plan was extended to cover all children up to the age of 12. Throughout the 1960's, the DHP expanded to cover certain services for children in families in receipt of social assistance and all adults on social assistance. The fees were recognized by the NLDA and it was accepted that the DHP would cover 90% of the cost of eligible services for the recipients. In 1992/1993, the province reduced the dental budget to $5.2 million from $7.2 million and the fees payable to dentists under the DHP were frozen. In the fiscal year 2005/06, the Dental Health Plan budget was further reduced to $4.475 million.

The NLDA implemented balance billing in 1995 as Medical Care Plan (MCP) fees for dental services under the Plan had been frozen. Balance billing is a patient co-payment for the difference between the dentist's fee and the reimbursement rate of the

dental program. Dentists advise that balance billing is challenging to the working poor and recipients of social assistance (86). The increased cost to visit a dentist may have a negative impact on utilization rates. This phenomenon is especially problematic for individuals at the lower end of the socio-economic spectrum. Due to the decrease in utilization rates there is concern that the policy goal of access to dental care services for children between the ages of 0-12 years is not being met. As a result of the reductions in utilization rates, the annual DHP budget had not been fully expended for several years.

**1.3 Dental Survey**

In 2005, concern over the drop in utilization rates within the DHP prompted the DoHCS to commission the Newfoundland and Labrador Center for Applied Health Research to undertake a Dental Provider Survey. The survey confirmed anecdotal reports that dentists were concerned about balance billing as they felt it was detrimental to their own practice as witnessed by a reduction in patient loads. Specifically, dentists were concerned that it reduced access to oral health care to financially disadvantaged families. Dentists are advocating revisions of the DHP that will allow more comprehensive coverage for financially disadvantaged families. Dentists reported that children now comprise only a small proportion of their patients. They hypothesize the decline in children visiting the dentist is due to inadequate cover of the DHP for financially disadvantaged children.

Although the dentists offer a hypothesis, there is no attempt to determine if the reduced subsidy is the real cause or if there are multiple factors that have adversely affected participants from using the DHP. It is plausible that part of the reason why

dentists have seen a decline in the number of children they treat is not due to the subsidy rate of the current plan, but rather the changing demographic structure of Newfoundland and Labrador. Fewer children might be going to the dentist because there are fewer children in the province due to a decline in the birth rate and out-migration.

The dental survey only serves a limited purpose as it is based on personal opinion. Therefore, it's difficult for the Department of Health and Community Services to make policy changes based on the survey results as they may be biased and advocate changes which will be more beneficial to dentists rather than to patients. This thesis examines the extent to which a frozen fee subsidy has resulted in a decline in DHP utilization. A key focus will be to examine the extent to which the subsidy freeze has reduced utlization among low income families. Finally, the thesis will examine whether a decline in utilization has had a deleterious effect on children's oral health.

### 1.4 Current Dental Health Care Plan by Canadian Province

There has been little research completed to assess the efficiency and cost effectiveness of the current Canadian dental health care system. The literature suggests that the foundation of our current system is based on assumptions, which have never been empirically tested. Each province and territory in Canada is responsible for implementing a dental health plan. Table 1 summarizes the differences in children's dental plan coverage by province and territory. Since there is little research completed on an ideal dental health care policy, it is not surprising how different dental policies are for each province and territory. For example, the DHP for Newfoundland and Labrador provides coverage for all children between the ages of 0-12 with a subsidized general

examination every six months while the Canadian territories provide no dental coverage for children. Furthermore, it has become a more common procedure to offer subsidies only to children who have been identified as low income (for instance BC and AB). Newfoundland and Labrador is the only province, which includes all children between the ages of 0-12 regardless of their financial situation. Additionally, the majority of provinces that provide dental assistance to children from low-income families only allow them one annual visit in comparison to Newfoundland and Labrador, which allows a child to receive a check up twice a year. As such it is necessary to question the validity of our province's current dental guidelines. The issue of recall intervals will be further explored in the literature review.

**Table 1**

## Dental Coverage by Province/Territory

| Province | Program | Frequency | Payment |
|---|---|---|---|
| PEI | 3-16 year olds | 1 x a year | $15/per child, $35 max. Parents pay 20% of total bill if income is less than $30,000 |
| NS | No dental program for children | N/A | N/A |
| NB | 0-10 year olds | 1 x a year | No co-pay |
| NL | 0-12 year olds | 2 x a year | No co-pay |
| QE | 0-10 year olds | 1 x a year unless there is a dental emergency | No co-pay |
| BC | 0-19 year olds | Not set; $ 700/ Year can be spent as person chooses | Over $700 |
| AB | 0-18 year olds | 1 x a year | 100% coverage |
| SK | 0-18 year olds | 1 x a year | No co-pay |
| MB | Rural children between 6-12 years of age; urban children 5-14 years of age | No dental exam, 1 x a year fluoride treatment | No co-pay |
| ON | Junior kindergarten to grade 8 | 1 x a year screening done at school | No cost for screening; 20-50% coverage for dental procedures |
| Yukon | Kindergarten to grade 8 | 1 x every 2 years by a dentist; 1 x a year by a dental hygienist at school | No co-pay |
| NWT/Nunavut | No dental program for children | N/A | N/A |

### 1.5 Purpose

The purpose of the research is to assess if there has been a decline in utilization of the DHP and if so, determine the factors associated with a decline in usage between 1996

to 2005 for children between the ages of 0 to 12.

By analyzing children's Medical Care Plan (MCP) utilization data we can see if the patient population changed its oral health care practices following the continual decline in subsidy from year to year. The subsidy (amount covered by the DHP) was frozen in 1995; however fees charged by dentists for dental procedures continue to increase. This means that the amount of the co-payment, the share of the bill that is the patient's responsibility, has increased over the last decade.

Additionally, the MCP database allows for an analysis of how demographic factors influence DHP utilization. This is done by linking the postal codes to Dissemination Areas (DA). A socio-economic profile is available for each DA thus where a person resides can provide a broad indicator of their socioeconomic level. Therefore, it will be possible to assess how an increasing fee difference impacted different socio-economic groups.

**1.6 Objectives**

The main research objectives for this thesis are to:

1. Conduct an extensive literature review. The review will focus on articles about children's dental health with the view to examining if there is an optimal dental coverage and the long term benefits of dental care and the potential cost reduction to government if an optimal dental care plan is in place.
2. Examine MCP demographic and utilization data to see how often dental services were used by children over time and across regions of Newfoundland and Labrador. It will provide a profile of the population utilizing the DHP by matching postal codes with the

income of an area using census information.

3. Compare the length of time between dental check ups over time as dental subsidies are reduced.

4. Compare the number of dentists by Census Division (CD) over time and across regions of Newfoundland and Labrador. Assess if the numbers of persons per dentist has an effect on the duration between dental visits. The number of persons per dentist will act as proxy and reflect an estimated workload of the dentist.

5. Compare the length of time between dental check ups across socio-economic deciles as the fee difference increases.

6. If there is an increase in durations, analyze the effect it has on the status of a child's oral health by assessing the incidence of dental caries and emergency visits.

### 1.7 Overview of Thesis

The remainder of the thesis will be broken down into 6 chapters. Chapter 2 will provide a review of the key literature on dental health in children. In Chapter 3, a detailed description of the data used in the study and the source of information the data was extracted from is provided. Chapter 4 contains the methods used in the empirical examinations of the main research questions. Chapter 5 provides the results to the research questions posed. Chapter 6 provides a discussion of the results and describes the implications of the findings. Chapter, 7, provides an overview of key findings, and suggestions on how the research may be extended in the future.

# Chapter 2: Literature Review

## 2.0 Overview

The literature review critically assesses dental research, with particular reference to the population of interest (children between the ages of 0 to 12). DMFT score (decayed/missing/filled teeth) is the primary universal outcome measure for oral health recommended by the World Health Organization (WHO) (94). DMFT assesses the prevalence of dental caries in an individual. The WHO (94) and Center For Disease Control (89) cite tooth decay as the most common chronic health problem and state early childhood caries are the main threat to oral health in children. The MCP data used is based on procedures performed such as caries being filled, thus the data does not include information on decaying or missing teeth. Since the data is not a perfect proxy to reflect all universal dental health outcomes, emergency visits were included to provide a more comprehensive picture of oral health.

Early childhood caries affect 1/3 of all children in the United States (88). The effectiveness of preventive primary oral health care to reduce the incidence of caries and decrease DMFT scores will be discussed and its potential long-term benefits will be appraised. Theraputic options to minimize the incidence of caries such as the use of sealants will also be explored. A cost benefit analysis of preventive dental care will be examined.

Key areas reviewed are dental guidelines on recall recommendations for children and the impact such policies have on oral health. Specifically, as the duration of time between dental check-ups increases are there changes in dental caries or DMFT scores.

An econonomic evaluation on the benefits and risk of extending recall intervals will be discussed.

The ability of an oral health care provider to correctly identify a child as high or low risk for dental caries will also be explored. This is of particular interest as the data has been divided into high risk groups, children with caries in the last year and low risk groups, children with no caries in the last year and the impact of a changing fee subsidy on durations between dental visits is explored.

Examination of the literature will be used to assess if there are cost effective solutions to reduce the cost of dental health care and if these solutions affect the quality of oral health care provided. In addition, literature on the usefulness of using quality of life factors to assisst in dental treatment planning and how poor oral health care affects a child's quality of life will be reviewed. Finally, methodological problems of these studies will be considered and discussed.

## 2.1 Literature Search

The steps taken to conduct the literature search are described below. Details on the research strategies taken are provided because of the limited amount of evidence on optimal dental care.

### 2.1.1 Prelude

The following procedure was completed prior to the literature review:

Step 1: Designing the research question

Population: Children between the ages of 0-12.

Intervention: Access to oral health care.

Comparison/control: Lack of access or limited access to oral health care.

Outcome: Decayed/missing/filled teeth/ plaque/gingivitis/caries.

Step 2: Determining the type of study

Ideally, a randomized control trial is the best as the design randomly assigns subjects to a treatment group, which ensures the groups share similar characteristics. Randomized control trials are the best to use as they provide the highest level of evidence; therefore, they provide the strongest causal relationship between variables (52). Randomized control trials in this area are infrequent, however, a few studies do compare recall intervals and the effect longer duration between dental visits have on the frequency of dental caries and or DMFT scores. Since RCT are limited, retrospective longitudinal studies will mainly be used. The main strength of using this type of study is several observations for a child can be made over a long period of time and the impact of access or lack of access to dental care can be assessed (52). This study is modeled in a similar fashion as several observations for a child are made over a 10-year period to assess the impact a widening fee differential has on interval duration between dental visits. Other types of studies included are meta-analysis, practice guidelines and reviews.

Step 3: Type of question

Therapy: comparing different groups based on their access to dental health care services..

Step 4: Search the literature

### 2.1.2 Search

The search used Boolean logic (AND), truncation (dent*), and synonymous terms e.g. universal child oral health/dental care/dental practices/dental polices, recall/time

between dental visits, child cavities/caries, and emergency dental/hospital dental visits. The databases used were the Cochrane Library, which is dedicated to systematic reviews, and PubMed (Medline). The first group of search terms, child oral health/dental care/dental practices/dental polices, provided a total of nine studies in PubMed and two in the Cochrane Library. The next set of search terms, recall/time between dental visits and oral health provided ten studies in PubMed and zero in the Cochrane Library. The third set of search terms, emergency dental/hospital dental visits and oral health provided two studies from PubMed and one from Cochrane. The number of articles was small; a solution was to broaden the search by using the more generalized term child oral health/oral health care, which resulted in thousands of articles. Samples of abstracts were read and most of the literature was out of scope for my research topic. To find relevant literature the limits of age (0-12), subjects (humans), language (English) and type of study (randomized control trials, meta-analysis, practice guideline, review) were used.

A fourth set of search terms, cost comparison of dental interventions, comparison and dental and treatment and costs, cost analysis of dental health outcomes, cost effectiveness of preventive dentistry, cost effectiveness analysis of dental plan/dental outcomes, and cost/benefits of dental plans provided nine studies from Pub Med. No economic analysis were identified that compared the cost of different dental interventions. However, there were a few studies that examined the cost effectiveness of a specific intervention, such as using dental auxiliaries or creating individualized oral health care plans. Limits were not used with these search terms as the number of articles were small.

### 2.1.3 Exploring Alternate Information Sources

In addition to using the above databases, the World Wide Web was utilized to find relevant material. Specifically, Google and Yahoo were searched using the terms listed above. However, the relevant articles were duplicates of those previously identified. Additionally, once an relevant article was found the reference section was examined and these sources were located and assessed to see if they were of value. The Canadian Dental Association (CDA) was contacted and provided background information on the research topic; a librarian at the CDA undertook a search for relevant material in the CDA database. Finally, research interests and projects at each Canadian university containing a dentistry program were compared with my research topic. They were identified by visiting each school's website and looking through professors/researchers project profiles. If a researcher examined the validity of dental health guidelines, dental recall intervals, the efficacy of using dental hygienists rather than a dentist, effects of poor oral health care on a child's quality of life and long term dental problems arising from lack of care they were contacted and asked to provide literature. Only two individuals were performing this type of research in Canada. However, when contacted only one researcher responded and provided a relevant article.

### 2.1.4 Criteria for selecting/rejecting articles

Prior to starting the literature review a series of eligibility requirements were composed to either reject or select an article for subsequent critical appraisal. In the majority of cases it was possible to ascertain if an article met the pre-determined criteria by reading the abstract. An article was rejected if it was not within scope of the research

interests. Numerous studies examined the guidelines of dental health care practices but failed to investigate the efficacy of such guidelines. There were many articles examining the effects of different recall times on children's oral health as this subject was relevant it was used in the literature review. Other criterion was a publication date of 1970 or later; very few articles on dental research had been produced prior to 1970. The majority of the literature used had publication dates of 1990 and later, however, when the literature was limited such as in the area of dental auxillaires and the impact on oral health a wider range of publication dates were necessary. Ideally, those studied should have been between the ages of 0-12 this was not always followed as the literature for children was so limited. For instance, research on cost effective strategies that provide both cheap and good oral health care are based on populations of all ages. With the limits in place (described in section 2.1.2) and the selection/rejecting criteria used when reading the abstracts, a total of 90 relevant articles were included in the literature review.

**2.2 Where is the evidence?**

The academic literature surrounding a standardized, universal oral health care plan is limited and the majority of oral health research is geared toward the adult population. Children comprise approximately 25% of the world's population, but only a tiny fraction of oral health research involves this group (1). There has been no large-scale longitudinal or randomized control study that followed children through childhood, comparing preventive and non-preventive approaches to oral health care. Furthermore, there has been no investigation on the impact these approaches have on a person's oral heath status later in life. This is problematic as dental problems and oral hygiene

practices in childhood have a dramatic impact on a person's oral health status as an adult (2); short study period does not allow us to see these long term effects. Preventive approaches in adult populations have been widely documented, but the research has failed to show a consistent association that prevention improved overall oral health (3-5). Research surrounding preventive dentistry draws an association between preventive practices and the occurrence of a specific dental problem such as caries (6, 7); however, prior studies have not assessed the association of prevention and more general outcomes of oral health status (2).

The need for a comprehensive, publicly funded dental health care plan is a global concern. However, the literature offers no clear consensus on an optimal dental guide (8). For example, in 1981 the World Health Organization created a policy called "oral health for all in the year 2000". The goal of the policy was to have "less than three decayed, missing, or filled permanent teeth at the age of 12 by the year 2000". This was the first global indicator of oral health. The World Health Organization left it up to each government to create a plan to achieve this goal (9). Creating a global indicator of oral health is an important step, but it needs to be accompanied by an empirically based plan of action to ensure all can achieve the goal.

Several common dental practices advocated in North America and Europe are poorly supported by empirical evidence. Rather, current guidelines are built on dental traditions dating back to the 1950's (10). Bader and Ismil (11) stated the reason why dental outcome data, which can be used to create evidence-based dentistry, is limited is due to time and financial restraints. Bader and Ismil (11) advocate that in order for dentistry to improve it needs to acknowledge the lack of research surrounding oral health

outcomes. In addition, dentistry needs to strive towards creating standardized outcome measures that are applicable to any general dental practice along with a standardized system for diagnostic coding. Finally, there must be an increase in the emphasis on the importance of oral health outcome in communities (8).

The literature indicates that dental health care policies remain constant; yet, the dental health care needs of society are changing. The current practices in place are old and (perhaps) outdated; they must be challenged and validated to meet the needs of an evolving population. Wang and Riordan (12) noted a decline in the incidences of caries in children residing in Norway, however, the recall intervals of care for these children remains constant. The British Paedodontic Society urges policymakers to recognize the reduction of caries and place more emphasis on other oral health problems such as gingival inflammation, calculus, and debris in children (13). Helminen and Vehkalahti (14) after completing a review of the Helsinki City Health Department in Finland stated, "Despite the rapid decrease in caries occurrence in children and adolescents, caries-preventive treatments are still mainly conducted under policies established at a time when caries were a widespread public health problem." Research by Wang et al (15) demonstrated that increasing recall times for adolescents in Norway to one year caused no noticeable negative effects on dental health, but resulted in a significant cost savings. In short, the policies currently in place need to be examined critically and empirical based dentistry needs to be employed when creating new policies.

**2.3 Prevention**

In recent years, there has been an increase in the adoption of preventive practices

in dental care settings. A study done by Brown (26) examined preventive practices in the US between 1959 and 1990, the reults showed there was an increase in preventive practices. For example, the percentage of patients going for an annual oral exam increased from 20% in 1959 to 48.1% in 1990 and the precentage of patients receiving prophylaxis increased from 19.9% to 38.6%. Manski et al. (55) demonstrated in 1987 that 30% of all dental procedures preformed in the United States were preventive. A study in Finland found 25% of dental care was preventive (39).

Does prevention affect the status of oral health care? In short, yes. A study by Gooch et al. (58) assessed the effectiveness of implementing a school-based sealant program as a means to reduce caries. The program was specifically designed for low-income families who had children with newly erupted molars. The program was created to provide evidence for the Center for Disease Control that sealants are an effective way to reduce caries. The study found that applying sealants to children reduced cavitations in comparison to a control group who did not receive sealants. It was recommended that sealants be used as means to prevent dental caries for high risk children.

A review by Ammari et al. (59) states that primary oral health care prevention needs to optimize the oral flora of the infant as this is when primary dentition occurs (59). Thus, they advocate creating preventive strategies that focus on the infant to prevent the occurrence of caries. Dietary considerations are a specific prevention strategy that has been shown to reduce the frequency of dental caries (59). Another study advocated exclusive breastfeeding during the first year in an infant's life, cleaning infant's gums after feeding and especially before bed and ensuring that an infant does not sleep with a bottle (60). All of the above items have been associated with declines in adverse dental

outcomes, such as caries.

A school-based intervention program promoting gingival health was completed over a 3-month period on 9 year olds (n=427) in 16 schools in Iran (74). The first group (n=115) received information on gingival health via class work such as doing puzzles that had oral health messages. The second group (n=114) received information via parents; the parents were given an oral health pamphlet and a diary to record when the child brushed their teeth. The third group (n= 111) received information via the classroom and parents. The control group (n=117) received no oral health information. The efficacy of the intervention was based on changes in a child's dental plaque and gingival bleeding. Improvements in gingival health was greatest in the parent based intervention group (OR=7.5, $p < 0.001$). The results indicate that a school-based oral health prevention program that involves parents may lead to significant improvement in gingival health.

Hochstetter et al. evaluated the effectiveness of a preventive education program on children's oral health (77). Outcome measures to evaluate oral health were plaque and gingival indexs and a dental exam. The study had 58 four year olds, selected from various preschools in Brazil. Half of the children (n=29) were randomly assigned to receive education about oral health, as were their caregivers and parents. The control group (n=29) did not receive the education portion. Both the control and the experimental group were given topical application of fluoride every six months. The results showed significant decreases in the plaque and gingival index and no significant increase in decay in the education group. The control group had a significant increase in the plaque and gingival index, and tooth decay. The study demonstrates that an education based prevention program can reduce negative oral health outcomes.

Stecksen-Blinks et al. (76) evaluated whether long-term consumption of milk with fluoride impacted the incidence of dental caries. The study was composed of 245 participants between the ages of 1 and 5 attending day care in Sweden. There were 14 day cares in the study and each day care had a parallel control and treatment group. The treatment group received milk with 2.5 mg fluoride per liter at lunch for 21 months while the control group received regular milk. The main outcome measure was the incidence of caries; the results demonstrated that children in the treatment group receiving milk with fluoride had a caries reduction of 75%. The mean DMFT score in the beginning of the study was 0.5 for the treatment group and 0.6 in the control group; at the end of the 21 months the treatment group had a DMFT of 0.9 and the control 2.2. The results indicated that fluoride with milk is an effective way to prevent caries from occurring ($p<0.05$).

In a research study by van Wyk et al (78) the impact of a fissure sealant program on dental health was investigated. The outcome measures were the number of decayed, missing and filled teeth (DMFT score). The study was coducted over a 7-year period (1995-2001) and involved a total of 2, 501 children enrolled at Mokonyama Primary School in South Africa. The dentition status of these children was compared to the Moretele Health district, the Moretele Health district was the control group as they did not receive any treatment. The experimental group, the children of Mokonyama Primary School, received sealant treatments every 6 months. At the end of the 7-year period, the children in the experimental group had significantly lower DMFT's in permanent dentition in comparison to the control group. The experimental group had 75.3% less caries than the children in the control group. This evidence further supports the hypothesis that prevention can significantly reduce dental caries.

Holt et al. (60) examined the efficacy of using dental health education as a prevention strategy to reduce the incidences of caries. They recruited a total of 1,321 new mothers with babies aged 2-12 weeks to participate in a 5-year study. The mothers were randomly assigned into three groups. Group one mothers received dental health education via home visits while group two received dental health education via the mail. A third group acted as the control and received no dental health education. The results demonstrated that groups one and two had a lower prevalence of dental caries (35% group 1, 28% group 2) based on a core= decayed, extracted, filled teeth in comparison to the third group.

Another prevention strategy is the usage of fluoride application. Several studies have explored the effectiveness of topical fluoride application in reducing and preventing caries. Lincir and Rose-Grget (63) investigated the impact of using topical fluoride on children between the ages of 3 and 4 over a two-year period in Croatia. None of the children had previously been involved in a preventive dental program. Children were randomly assigned to four different groups; group one received topical amine fluoride solution with 10,000 ppm F every two months (n=55), group two received topical amine fluoride solution with 5,000 ppm F every two months (n=53), group three received topical amine fluoride solution with 5,000 ppm F once a month (n=61) and group four received a placebo (n=30). The results demonstrated lower DMFTs in all groups receiving topical amine fluoride solution in comparison to the control group. However, the largest reduction was seen in group three, these children experienced 31% less decay and had 34% fewer new DMFTs in comparison to the control group.

Hardman et al. (62) did a cluster randomized control trial over a two-year period to

assess the impact of twice-yearly applied fluoride varnish on reducing caries. The sample consisted of 664 children, aged 6-8, from 24 state primary schools in communities that were considered underprivileged. Children were assigned to either receive fluoride varnish twice a year applied by dental therapists (n=334) or not to receive fluoride varnish (n=330). The results indicated that there was no significant difference in the incidences of caries between the two groups. The only significant difference was a reduction of caries in for small enamel lesions for the children receiving the fluoride varnish. The study concluded that applying fluoride varnish twice a year was not an effective way to reduce dental caries and should not be employed as a prevention strategy. A limitation of the study is the reliability of the dental therapists to diagnosis caries.

Though there is a general consensus that prevention helps to improve oral health, the methods of prevention vary widely within clinical settings. For instance, prevention for one dentist may constitute an annual recall visit while for another biannual recall visits. UK dentists were surveyed about their opinions on preventative treatments, the results of the survey showed that many dentists assumed dental caries could be "treated away" by restorations and a general recall visit. Furthermore, dentists believed the traditional approach of invasive dental procedures versus the more non-invasive dental procedures were equals and either would result in good oral health (40). The study recommends that dentists need to move away from the traditional invasive procedures because these approaches fail to address the root of the problem (40): why a child has dental caries. If the child receives no education to improve oral health care practices, behaviors will remain unchanged. By simply fixing caries it does not prevent the child

from getting additional caries later on in life.

Sheiham (24) completed a review on how dental services impacted the rate of caries in children ranging in age from 5 to 12. The review showed that dental services did not significantly reduce the rate of caries. Sheiham (24) suggests the reduction in caries is due to prevention. Additional studies further support this finiding that it was not clinical dental services that caused the decline in dental caries; rather they attribute the reduction to the addition of fluoride in toothpaste (14, 27).

Research shows that when a dentist is knowledgeable about a child's socioeconomic circumstance they are in a better position to help as it provides additional background on a patient. People who are economically disadvantaged are more prone to consume foods that are high in sugars, which are highly associated with dental caries (1, 29). By understanding the circumstances a child faces a dentist can educate the child and a child's parents on effective self-care methods to improve oral health and promote healthy eating as a means to reduce dental caries. As the number of children living in poverty increases there is more need for preventive dentistry as this group is at the highest risk for dental diseases (5). Additionally, they face the most difficulty in accessing and paying for dental care. Forrest et al. (44) claims there is a movement away from looking at socioeconomic status when creating dental polices and low socioeconomic groups are being lumped together with the general population because it is financially cheaper to do so. Thus, those in lower socioeconomic groups will not be given special attention such as, receiving more detailed dental care advice about healthy food choices and preventive practices that can be done in the home. It seems this would lead to poor dental policies, as the policies would fail to address the unique oral health

care challenges of lower socioeconomic groups.

Clovis (9) believes in an individualized prevention plan where the status of oral health is not the sole determinant for treatment. Other factors dentists need to assess when providing services to the patient population are demographic, economic and social trends. These factors have demontrated a significant impact on the oral health of an individual (1, 9).

The demographics of Canada are changing; there is a large increase in adults over the age of 65 and an increase in single parent families living below the poverty line. The increased incidence of single parent households is thought to negatively impact a child's oral health care as there is less money available to spend on dental visits (9). Furthermore, there is an influx of immigrants into Canada and a large proportion of immigrants are from countries lacking preventative dental health programs. This means that some children who are recent immigrants may have poorer levels of oral health as well as different knowledge of services available. There are also limitations to accessing preventative dental care within Canada, as there are many remote and geographically isolated communities without regular dentists.

Prevention has been shown to improve oral health care, but there is little research showing how prevention stacks up against other alternatives. At the moment there is clear evidence that prevention is useful in reducing dental caries, but perhaps there are even more effective ways to reduce caries that have not yet been explored. For instance, the best dental plan could be a combination of individualized care in conjunction with preventive measures such as regular recall intervals. Research on the effectiveness of preventive oral health procedures is difficult to follow as some of the benefits of these

services may not be become evident until years later (2, 44).

**2.4 Quality of Life**

Though the literature is limited, the concept of how good oral health care can affect our quality of life has been explored. There are several interpretations of the meaning 'quality of life', however, McGrath and Bedi's (16) definition will be used as it's the most comprehensive, "Oral health-related quality of life refers to the social and psychological impacts of oral health, the ability to eat, speak, and socialize without active disease, discomfort or embarrassment and which contributes to general well-being" (page 137).

Locker (17) explored the relationship between oral disorders and their impact on a person's quality of life; in addition, he defined numerous measures to assess how oral disorders affected a child's well being. Prior to this research outcome measures were focused on older populations and these studies were statistically weak as measures varied greatly in the number of questions, health concepts, and scoring (18). Also, the research lacked evidence to support that a change in a person's quality of life was due to a specific dental intervention and test-retest reliability was only checked for a few of the outcome measures. In the 1980's, the health care research community recognized the importance of using quality of life measures (16). These quality of life measures are very new to the dentistry research community and outcome measures often lack validity as they fail to identify what quality of life is and its impact on oral health or vice versa (17).

Researchers in the United States and Europe assess oral health and its relation to quality of life by using the Child Oral Health Quality of Life Questionnaire (COHQOL).

The COHQOL is the only questionnaire designed for children; it is a recent development and as of yet no assessment has been made on its usefulness (19). However, the introduction of the COHQOL is important as it recognizes that now we think about oral health care is changing. The COHQOL can be applied to all children despite differences in dental disorders/health and the survey is composed of questions regarding oral symptoms, functional limitations, emotional well being and social well being. Additionally, a separate scale of 14 questions assesses how a child's oral health directly affects the child and the child's family. The COHQOL is currently being used in a few studies; once these studies have ended and data are collected it will be possible to compare quality of life scores of children suffering from an oral disorder to those who do not have an oral disorder. Additionally, quality of life can be compared prior to an oral procedure and after and can demonstrate to what extent an oral health intervention affected a child's quality of life. The preliminary results thus far show that dental caries have a large affect on the emotional and social well being of children ranging from 11 to 14 year old (17).

Research has shown that quality of life is an important aspect in dental care and can be of great value in assisting dentists who work as independent practitioners (16, 21). Dentists working, as sole-practitioners need guidelines as to which products and procedures are the best to use. In the United States it is being suggested that quality of life measures be used to aid dentists in deciding on an appropriate procedure. The system would work by highlighting how different treatments would be expected to impact a patient's quality of life (16). A review by McGrath and Bedi (16) suggests that patients will be more compliant with their treatment plans if a dentist takes into account quality of

life factors and educates the patient on how a treatment could improve the patient's quality of life. It should be noted this assumption was not based on empirical evidence, additional studies assessing dental compliance in relation to quality of life need to be explored to answer the following question: Does compliance (brushing teeth and flossing) increase in children when they are educated about the impact poor dental health can have on their quality of life? This piece of evidence-based dentistry is still in its early stages and warrants further investigation.

Clear communication is essential between a health care provider and a patient. However, a study shows that communication may be problematic in the field of dentistry. Communication problems may be attributed to dentists using complicated dental terms when explaining procedures and benefits of treatment to patients (8). Since patients may not understand the importance of a procedure they may decide against treatment, which could lead to a decline in their quality of life. McGrath and Bedi (16) advocate using quality of life measures when explaining treatments and procedures to a patient; they believe it will give the patient a clearer understanding of the procedure and help them in their decision making process.

Quality of life measures can help direct dental policymaking. Research by Chen and Hunter (23), and Slade and Spenser (21) demonstrate how quality of life measures can be used in resource allocation. In the past, clinical measures used to assess oral health care were based primarily on what dental providers thought were important. However, these clinical measures failed to take in to account social or psychological aspects of oral health (22). Since clinical measures are limited in what they define as good oral heath, new policies for dental health care may need to be revamped to include both clinical and

quality of life measures.

By integrating quality of life measures into dental practices there is the potential to improve current polices (78). Weintraube (79) believes that quality of life factors can be used to measure the efficacy of dental health plans and policies should be altered according to changes in quality of life scores. The Evidence Based Dentistry Series (66) examined the usefulness of quality of life measures; they advocate using quality of life measures to determine the success of a dental program. They recommend using quality of life as an outcome measure as it allows the patient to tell the clinician how a dental problem is affecting their life using their own words. They believe the patient is the best judge of how a problem is impacting their quality of life.

**2.5 Recall Time**

Industrialized nations around the world are experiencing a similar trend; the number of children with dental caries has been steadily declining since the late 1970's (24-28). England and Wales in 1983 underwent a National Survey, which examined children's dental health between 1973 and 1983. The result of the National Survey showed that 72% of 5-year-old children in 1973 presented caries as compared to 49% in 1983 (24). Similarly, Norway experienced a decline in the number of 12 year olds with decaying teeth; in the 1970's a 12 year old had on average 10 decaying teeth while in 1993 it was reduced to one decaying tooth (24). In Denmark caries were reduced from an average of five to one tooth per child in 12 year olds during the period of 1979 to 1991 (29).

In the early 1970's industrialized nations created dental care policies to combat

the high number of caries in children. These dental care policies included specific guidelines for recall intervals. The recall interval is the time period between recall examinations (70). Polices on appropriate recall intervals were created at a time when dental caries in children was a large, widespread dental health problem. For instance, children residing in the United States began receiving preventive oral health care in 1959 as a means to reduce dental caries. The United States implemented policies to recall children every 6 to 12 months for dental check-ups; the incidence rate of dental caries was greatly reduced by 1993 (27). The main contributor to this reduction in caries was a shift of focus to preventive dentistry, specifically the addition of fluoride to public water sources and in toothpaste (14, 27).

Dental care recall policies have changed little since the 1970's; these policies may be outdated as they reflected a time when dental caries were much more prevalent and before the rise of preventive dentistry. There has been over three decades of debate as to an optimal recall interval. Now that dental caries have been drastically reduced and there is more emphasis on the prevention of caries, the policies may need to be modified in order to reflect our current oral health state. By updating recall intervals, it may be possible to reduce unnecessary costs and apply the saved monies to other areas in dental care to improve oral health.

Industrialized nations addressed the problem of high dental caries in children by creating their own national dental policies. There is agreement that the purpose of the recall visit is to detect caries, however there is much disagreement on how often recall routines should be preformed and if they should be done by a dentist versus a dental assistant (31-35). Additionally, there is controversy over the appropriate time period

between recall intervals for children labeled as high risk or low risk (36). Studies have shown differences in recall intervals. For example, Finland provides free annual check-ups for children and adolescents but the policy in the United Kingdom is to provide free biannual check-ups. In Sweden they recommend 13.1 months between check-ups while Iceland suggests 7.4 months, Denmark 9.2 months, and Norway 13.5 months (15). In Canada recall intervals not only differ from other industrialized nations, but they differ between provinces and territories (see Table 1).[1]

A 2003 review by Davenport et al. (57) demonstrated no high quality studies had been done that supported or refuted a six-month recall interval. Quality was lacking as the interventions were poorly explained which means there may be confounders that affect the outcomes. Validity was questionable in several studies as patient characteristics differed between comparison groups and how patients were selected created biases. The review cited the main deficiency in the research was a lack of external validity as there were no consistent findings across the studies that demonstrated how different check up intervals impacted the frequencies of caries or periodontal disease. None of the studies assessed whether check-up intervals impacted quality of life measures.

There is no clear consensus between or within nations as to what is an appropriate recall interval. However, without adequate evidence it is not possible to know which policy is the most effective in promoting sufficient, cost-effective oral health care. The Unites States Preventive Services Task force found "little or no scientific evidence on which to recommend any specific optimal interval between dental examinations." (42) Benn et al. state "The traditional basis of six-monthly recall examinations for all patients

[1] This information was collected by the author.

is shown from the literature to have no scientific support." (43)

There has been ongoing international debate on recall intervals as nations are trying to balance cost effectiveness while maintaining clinical effectiveness. There have been several studies which determine the benefits and harmful effects of different recall intervals. A recall visit is a planned time for a patient to return, when at their last visit they were in good oral health. A primary function of the recall exam is to detect signs of oral disease, in particular dental caries (71, 74). It is advocated by several studies that the recall visit should also contain an 'advice' portion where a clinician provides professional advice to prevent dental disease (71-73). The advice portion would contain ways to prevent caries (e.g. using fluoride toothpaste), dietary advice (e.g. avoidance of high sugar foods) and modifiable risk factors for oral disease (e.g. smoking). Many clinicians perform the advice portion; however, education is not officially part of every dental check-up (74). Deep (73) recommends using the recall examination for both primary and secondary prevention; primary prevention is the advice component, which will prevent oral disease, and secondary prevention is to identify health oral disease early and stops its progression.

Wang et al. (15) randomized 185 participants aged 3, 16 and 18 into two groups. Group one were recalled once, every 24 months, and group two were recalled twice, every 12 and 24 months. The results demonstrated a greater increase in DMFT scores in group one which had the longer recall interval, but it was not statistically significant. The results in the study indicate that extending the interval between dental check-ups may not significantly impact oral health.

The National Research and Development Center for Welfare and Health in

Finland set out to examine the frequency of annual examination of children and provide recommendations for recall intervals (39). The study separated children into two groups: low caries risk or high caries risk determined by the patient's oral health history. They recommended high caries risk children needed a check-up every 9 months and low caries risk children needed a check-up every 1.5 to 2.0 years. The research indicated that increased duration between check-ups for the low risk group caused no reduction in oral health. The study deduced that if this new recall policy was implemented it would result in a 15% program cost reduction in Finland.

The National Research and Development Center for Welfare and Health in Finland advocate the additional money should be used for children who are at a high risk for dental caries (38). However, the study recognizes a limitation in that the screening measure used to assess risk caries is inaccurate. For instance, the strongest single predictor for high risk is if a child has a history of caries. The method is problematic as there was a high likelihood of false positives ranging between 35-45%, which means individuals with past caries, would be categorized as a high risk when they actually are at a low risk for dental caries (39). Measures to assess risks for oral diseases need to be improved as categorizing individuals based on their history of caries seems to be ineffective.

A review by Kagihara et al. (88) identifies factors associated with higher risks of early childhood caries. The main factor is socioecnomic status, children from low socioecoomic backgrounds have twice as many caries in comparison to children from affluent backgrounds and their caries are more likely to go untreated (88). Other factors that place children at higher risks for caries is lack of access to dental care, lack of

preventive measures like water fluroidation, fluoride toothpaste and sealants amd lack of education of the improtance of oral health. When these factors are not addressed oral health declines in the very young. A study by Harris et al. (89) stresses the importance of identifying the factors that place children at a higher risk for dental cariers before their teeth erupt to allow for optimal preventive outcomes.

## 2.6 Cost Reduction Strategies

There is an ongoing debate whether dental health care for children can be both good and affordable. There are several studies dedicated to refining current dental care policies to reduce cost while continuing to provide a high quality of oral health care. In the following sections, cost reduction strategies and the effect they have on a child's oral health status are discussed. It should be noted that while there is literature on this topic, there is no clear consensus on the best balance between cost and quality of care.

### 2.6.1 Overview

Several studies (12, 16-18, 54) have shown the general well being of an individual is affected by their oral health. A person with an oral disease or condition generally has a poorer state of health. Additionally, certain medical conditions negatively impact oral health. White (45) states there has been little attention relating the cost and consequences of neglecting oral health care. He warns the incurred costs are much higher then need be if oral health care is readily accessible. The costs of neglected oral health care are significant for the patient, their families and to third party-payers (8). This point is supported by Cohen and Manski (46) who observed that financially disadvantaged

patients would not seek out traditional oral health care services, such as a dentist, because it is too costly. Rather they seek care from a physician either in an office or hospital setting, an overwhelming majority of observed cases (68.1 %) had prescriptions from a physician to treat dental problems, such as tooth pain and oral abcesses.

To reduce the cost of oral health care several strategies can be employed such as prevention, individualized approaches to oral health care, increased responsibility for dental hygienists/auxiliaries, and creating standardized guidelines for dental care based on empirical evidence.

### 2.6.2 Prevention

A way to reduce oral health care expenditures is to provide preventive services as these are empirically proven method to reduce dental diseases (9, 25, 28, 47). A reduction in dental diseases will minimize costs in children's dentistry, in addition to having the long-term benefit of reducing costs in adult dentistry (49). Harris (47) advocates that children receive dietary counseling as diet contributes to dental caries and a change in diet can prevent or slow down the progression of caries. Children should be advised to reduce the amount of sugary snacks and acidic drinks or food (1). Furthermore, fluoride treatment such as daily use of toothpaste with fluoride is effective in reducing caries (5). As mentioned earlier, the dramatic reduction of dental caries in recent years is partially attributed to the increased usage of fluoride toothpaste (14, 41). Fluoride increases the tooth's resistance to erosion (49). Dental caries have been on a decline; however, the decline is in smooth surface caries. Pit and fissure caries have experienced little decline (48). A preventable method to reduce caries in these areas is

fissure sealants, which have already been discussed in the previous section.

In rural areas it is difficult to recruit and retain dentists. It has been suggested this lack of dental care can be improved by using primary care providers to provide preventive services. A primary care provider could be a family physician, pediatrician, registered nurse or nurse practitioner. Evidence based dentistry demonstrates that preventive services would have a huge benefit for young children and for low-income families (12, 30, 31). A systematic review was conducted on the use of primary care providers to supply preventive dental services by Sohn et al. (30) and it concluded there was no evidence yet on the efficacy of using primary care providers to screen for oral health problems. More research in this area is needed, especially considering the potential benefits using primary care providers can have on improving oral health in rural areas.

### 2.6.3 Individualized Oral Health Care Plans

Cost reduction may be realized through individualized oral health care plans. For instance, the American Dental Association (ADA) recommends children who are at a low risk for dental caries (defined as those with no carious lesion in the prior year) visit the dentist once a year for a recall examination (50). Children who had one carious lesion in the prior year are categorized as at moderate risk for caries and it is recommended they visit the dentist every six months for a recall examination. Children with multiple carious lesions in the prior year are considered high risk and the ADA recommends dental visits every three months (50). Nainar (25) agrees that recall examinations should be based on children's recent caries experience and notes that not every child needs to

visit a dentist biannually for check-ups.

Wang et al. (15) discuss the concept of appropriate dentistry. Appropriate dentistry is the combination of cost conservation and a movement toward individualized dental care (31). It urges that dentistry needs to be redefined as currently there is a tendency to assume that financial restrictions to oral care means minimal care rather than appropriate care. Even if a patient is unable to afford the best treatment there are many alternative treatments that satisfies a patient's oral health care needs. The paper stresses the importance of patient interviews and history as they provide crucial information on the patient's financial situation and will help the dentist determine the best option that will provide good oral health care and be affordable to the patient.

Hietasalo et al. (92) assessed the cost-effectiveness of an individually designed oral health program for caries control in Finland from 2001 to 2005. Children between the ages of 11 and 12 with at least one carie were randomly assigned to a experimental group (n=250) or a control group (n=243). Children in the experiemental group received a caries-control regime based on their individual needs and received standard preventive care i.e went to the dentist twice a year for a check-up. The control group only received standard preventive care. Care for children in the experimental group was provided by dental hygenists who taught preventive procedures such as how to brush teeth properly and counseling on dietary choices. The dental hygenists main purpose was to identify factors that led to previous caries and create a plan to eliminate these factors. The DMFT increment was decreased by 44.3% in the experiemental group in comparision to the control group. The individualized caries-control program was more effective, but in the first year it also cost 34.07 euros more per child than the control group. However, as the

program continued the averted DMFT lead to the program being less expensive than standard care. A limitation to this study is it failed to defined how needs were assessed and by whom.

Axelsson (93) evaluated the effects of an individualized caries prevention program based on a child's predicited caries risk over a 20 year period. Caries prevalence and incidence was predicted based on a child's Plaque Formation Rate Index (PFRI) and salivary mutans streptococci (MS) levels. Based on their caries risk and age, all children between the ages of 0 and 19 residing in Varmland, Sweden in 1979 received individualized dental care provided by a dental assisstant/hygienist. Over the 20 year period the percentage of 3 year olds that were carie free increased from 51% to 97%. Caries incidence was decreaed by 90% in all risk and age groups. The study collected data by the Swedish Board of Health and Welfare, and determined the mean treatment time by a dentist per child in 1979 was 1.75 hours in the county of Värmland. However, the effect of an individualized preventive program by dental assistants/hygienists decreased the mean treatment time by a dentist to 20 minutes per child in 1999, which is the lowest value in Sweeden. This is due to the fact that the need for restorations was minimized. The total costs per child per year in Varmland, including the preventive program by dental assistants/ hygiensts was $120 US compared to $135 US for the rest of Sweden. The individulaized prevention program bsed on risk and age resulted in high cost/benefit ratio.

### 2.6.4 Dental Auxiliaries

Riordan (28) argues it makes little sense to decrease a dentist's income as a cost-

reduction strategy as it will drive a dentist to leave a public practice for a private practice, noting this has already occurred in Nordic countries and Australia. Furthermore, salary cuts may discourage students from entering dentistry. Therefore, cutting incomes in dentistry is not an effective way to reduce dental costs. Rather, it may leave fewer dentists overall and fewer dentists willing to practice in the public system. The costs of dental procedures can be expensive, especially when paying out of pocket: Riordan (28) states that a potential way to reduce cost is to use other dental health care professionals to do certain dental procedures.

Riordan (28) and several other studies question whether dental procedures can be performed by somebody other than a dentist (31-34). These individuals are called dental auxiliaries and they can be dental hygienists, dental nurse or dental educator. In some parts of the world there is opposition to using dental auxiliaries to assess and perform dental health care procedures. For instance, in Europe dental auxiliaries have very limited patient duties because of professional opposition which prevents the delegation of patient responsibilities to dental axillaries (28).

In New Zealand during the late 1960's there was a shortage of dentists. To fill the need a dental nurse was trained to provide almost all routine dental procedures needed by children (33). In 2004, a Surgeon Generals Report called "Oral Health of America" was produced (79); the report identified lack of access to dental care services for disadvantaged children. To fix this disparity, Nash (81) recommends using the New Zealand model of training allied health professionals to be pediatric oral health therapists. These therapists would be nurses with an additional two years of training in how to care for children's teeth.

The usefulness of dental auxiliary personnel to deliver dental services has been thoroughly documented. Barnes (82) demonstrated that dental hygienists could significantly reduce dental caries in children by teaching self-care procedures and professionally applying topical fluoride. Douglass and Lipscomb (30) showed that the use of dental auxiliary personnel allowed for more services to be provided, especially in rural areas. Robinson and Wood (83) evaluated a new program in Alberta that trains dental hygienists to be health promoters. An increase in the health promotion capabilities of dental hygienists lea to prevention of adverse dental outcomes such as plaque build-up and caries in that province. Monajem (84) demonstrated that dental hygienists can offer services in the areas of primary and secondary disease prevention, the results of using dental hygienists services have shown it is cost effective and an efficient way for children to receive oral health promotion.

It may be argued that using dental auxiliary personnel lowers the quality of care, but it has been shown that auxiliaries meet the same expected standards of dentists and the quality of care is not affected. Bolin (85) evaluated the treatment provided by dental health aides in Alaska. The dental health aides were evaluated on quality of care and incidence of adverse events in comparison to dentists. Bolin viewed past dental records of patients treated by dentists and dental health aides for similar procedures. The results showed no significant differences between the two groups for consistency of diagnosis, treatment recommendations and adverse complications following a procedure. In Alaska, there is a necessity to improve oral health in the Native population and the author recommends utilizing dental health aides to act as a long-term solution to this problem.

A similar evaluation was done by Desai et al. (86) in Melbourne, Australia. In

Australia, there is a lack of a public oral health plan for children with disabilities and it is difficult to obtain dental care for this population. Desi et al. (86) assessed the efficacy of using dental auxiliaries to fill this gap in dental care. The results demonstrated no significance differences between dentists and dental auxiliaries in diagnosis and treatment. It is recommended that dental auxiliaries be used to care for the oral health needs in children with disabilities.

In Prince Edward Island, Roemke (31) conducted a study where dental hygienists were used to perform expanded procedures in restorative dentistry. Roemke (31) showed that dental hygienists improved productivity and that patients had no problem receiving care from auxiliaries rather than an actual dentist. In Philadelphia, research was conducted at a dental health clinic located in an elementary school using one dentist and four expanded function dental auxiliaries (EFDA's). The results were increased productivity and patient acceptance along with a decrease in operating costs (35). Douglas and Cole (39) assessed the quality of services delivered by EFDA's and found in ten separate studies that there was no difference in the quality of care provided by EFDA's and dentists. Actually, three of the ten studies showed a higher quality of dental care when it was provided by EFDA's. Several studies have demonstrated that dental auxiliaries are able to perform restorative dentistry without reducing the quality of care and using dental auxiliaries means an increase in productivity at a fraction of the cost (28-38).

Jokela et al. (94) evaluated the economic benefits of using dental auxillaries in a risk-based caries prevention program in preschool children over a 3 year period in central Finland. Risk assessment was based on the presence of mutans streptococci in plaque

and/or caries by the age of 2; if either was present children were classified as 'high risk'. The 'high risk' children (n=299) received an annual dental visit, biannual application of fluoride varnish and dental health education in compairison to children in the control group (n=226) who received an annual dental visit. Dental assistants were responsible for screening children's risk level and for providing fluoride varnish and dental health education. Eleven percent of the 'high risk' children receiving additional care from a dental assistant had caries in comparision to the control group where 23% of children had caries. The study calculated cost per child based on time spent on dental visits over the 3 year period. The cost per child per 3 years in the risk based caries prevention program was 54 euros. The cost per child per 3 years in children in the control group was 69 euros. The results demonstrate that dental assistants can be effective in reducing dental caries and costs.

**2.7 Limitations**

The literature on oral health care varies in its recommendations on an optimal dental care plan and only a tiny portion addresses the unique oral health problems facing children. Additionally, there is a lack of research comparing alternative dental treatments and assessing the effects they have on reducing core oral health symptoms/diseases. Randomized control trials are the most scientifically sound as the design randomly assigns subjects to a treatment group, which tends to ensure the groups share similar characteristics. Randomized control trials are the best to use as they provide the highest level of evidence; therefore, a study can provide the strongest causal relationship between variables and the impact of a treatment can be evaluated. However, much of the research

surrounding recall intervals simply states that there has been a decline in dental caries and its assumed the reason for this decline is due to the implementation of regular recall check-ups. However, other studies argue that the reduction in dental caries is due to the widespread use of fluoride toothpaste (14, 41). There may be several variables, which have contributed to the decline in caries, but the current data fails to answer the question which variable or combination of variables is superior to use as a main treatment program because none of the studies assessed a treatment group against a control group. Since the research does not include separate manipulations of oral health intervention the effects are confounded and in some cases cannot be clearly interpreted.

A large portion of the recall research involved several observers determining whether a child was at a high or low risk for caries. The main criterion for being placed as high risk was a history of dental caries (26). If placed as a high risk for caries a child would have a shorter recall time than someone who was considered low risk for dental caries. The diagnosis was not always made by a trained dentist, but rather, by parents and dental assistants. This is very problematic as it lowers the internal and external validity of the study. For instance, the findings from this study may not be applicable to the general population of children, as the study may have incorrectly diagnosed the child as high risk when in reality they are at a low risk for dental caries. The study did cite this as a limitation and reported that 35-45% of children were misclassified as high risk when in fact they were at a low risk for dental caries or as low risk when they were at a high risk for dental caries. However, no alternative classification system were suggested to amend the problem.

In other research, the methods used to test the efficacy of regular recall visits

were done using a fixed design; in a fixed design the treatment plan does not change regardless of the results (10-15, 24-28). The results demonstrated that there were no significant adverse dental health outcomes when recall intervals were extended past six months. With a fixed design children will be recalled every six months even if they have or do not have signs of dental disease. Research is designed to add to the field of evidence-based dentistry, thus studies should parallel a clinical setting. In a clinical setting it seems like it would make more sense to use an adaptive treatment strategy where if regular recall visits were deemed as ineffective in improving the oral health status of a child then another treatment could be additionally added.

When assessing quality of life measures in relation to oral health the domains were assessed mainly by questionnaires and done by several observers; as there were multiple observers that administered the questionnaire it is prone to observer variability, which increases the random error and decreases the precision of the study. Also, since the quality of life measures were judged by several different sources that ranged widely in their perspective it opened the studies to interviewer bias. In addition, the questionnaires were not included in the study reports making it hard to assess potential questionnaire bias. For instance, questions may lack clarity and be confusing for a participant to understand; without access to the questionnaire it is impossible to assess its quality. Several studies (16-20) did not use any precautionary measures to reduce random error and systematic error, a solution to increase the validity and reliability of the study is to provide training for the observers and ensure there is a standardized method implemented when recording results. Besides questionnaires, checklists were also to be completed by parents and children. Participants in studies (18-20, 23) were not blinded

and were aware what the research was about. Checklists used to measure quality of life could be improved by containing a wide range of questions to disguise the nature of the research and blind participants. By blinding and including decoy variables in the checklist it would have confused the observers and helped to reduce attribution bias.

Research has shown several ways to improve oral health care services at a reduced cost (32-34, 46, 54, 58, 81-85). The intensity of the dental "interventions" in these research studies lead to questions in regarding of their ecological validity. These new interventions are manageable in a research setting; however, it is unlikely that many of these cost-reduction suggestions would be followed in a clinical setting of routine dental care. It appears that cost reduction strategies should focus on health promotion and prevention in the community rather than in a clinical setting.

**2.8 Conclusion**

Evidence-based dentistry is evolving and dental health literature is growing. Currently, the evidence varies in its recommendations: this is especially true of recall intervals for dental check-ups. One of the main objectives of this research is to assess the level of decline in the usage of the DHP as it becomes more expensive for individuals to visit a dentist. Currently, the plan provides subsidized biannual check-ups. It is expected the duration between check-up visits will increase as the price to the consumer increases, thus individuals will wait longer than six months for a dental check-up. The literature surrounding recall intervals suggests only children at a high risk for dental caries need to visit a dentist every six months (31-33). Furthermore, the recommended recall time for a check up has been extended by Norway to 13.5 months and Finland to 1.5 to 2 years

without showing a decrease in a child's oral health care status (15). Thus, it would appear that longer durations between check-ups for children in Newfoundland and Labrador should have little impact on the majority of children's oral health care status. The study's results can provide empirical based evidence to the Department of Health and Community Services on the efficacy of the current dental plan in place.

Based on research surrounding dental health and quality of life it has been found that children in lower socioeconomic groups are at a dental disadvantage because they are more likely to consume high sugary foods and acidic beverages such as soda pop (1, 29). Due to these dietary reasons, children in lower socioeconomic status groups are at a higher risk for dental caries (9). While it is expected that longer durations will have little impact on the majority of children's dental health status in Newfoundland and Labrador, it is also expected that longer durations may have a larger impact on oral health status in the lower socioeconomic groups.

# Chapter 3: Data

## 3.0 Introduction

The study employed a retrospective longitudinal approach using administrative data from the Medical Care Plan (MCP) database. This chapter will provide the purpose, research hypothesis, data sources, study population, and a description of the variables and any variable manipulations. All data manipulations and analysis are conducted in the statistical program STATA.

## 3.1 Purpose

The purpose of this research is to analyze the utilization rates of children using the Dental Health Plan (DHP) between 1996 and 2005 by examining the MCP database. Analyzing the utilization rates will help determine the current client population, DHP utlization patterns and will help to assess the need for changes to the DHP in the future. Additionally, various statistical techniques will assess factors that may impact usage of the DHP in children aged 0 to 12 years old in Newfoundland and Labrador. The purpose of doing this is to determine the association between a decrease in the fee subsidy and usage of the DHP. Also, examine if the hypothesized decline in utlization had an adverse effect on oral health as measured by caries and emergency visits.

## 3.2 Research Hypothesis

The primary focus of the study is to assess multiple factors associated with changes in children's utilization patterns of the DHP from 1996 to 2005. A record is

created in the MCP database when a dental provider submits a FFS (fee-for-service) dental claim for children between the ages of 0-12. Dental claim records are also submitted for adults and their adolescent children who are recipients of social assistance. Since the MCP database contains dental claims for a wide range of ages, data manipulations were performed to ensure the database only contained dental records for children under the age of 13. These manipulations will be discussed in further detail throughout this chapter.

The dental subsidy is the government's contribution for dental procedures covered under the DHP. Each year the Newfoundland and Labrador Dental Association (NLDA) creates a fee guide with the recommended amount a dentist should charge per procedure. As time progresses, the recommended fee for most dental procedures is increasing while the dental subsidy under the DHP remained constant. In 1995, the DHP froze subsidies for dental procedures and the subsidy remained frozen from 1996 to 2005. The fee difference, which is the difference between the total cost of a dental procedure and government's contributions, widened. Dentists bill this fee difference directly to the child's parents, thus it is hypothesized that as the fee difference increases there will be a decline in utilization of the DHP. Furthermore, it is expected the increasing fee differential will have a greater impact on the lower socioeconomic status groups, since they will have reduced capacity to pay for non-urgent services.

Utilization of the dental plan over the 10-year observation period will be measured by the length of time between visits to the dentist for maintenance procedures. It is hypothesized that as the fee difference increases, making it more expensive to obtain dental care, there will be longer durations between dental visits and decreased usage of

the plan.

The dental health policy is designed to offer subsidized biannual check-ups. However, due to the increasing fee difference, the policy's goal of providing biannual check-ups may not be fulfilled; the results may demonstrate that the time between visits to see a dentist is increasing past six months.

If the results show the time between dental check-ups is increasing, it is important to assess the impact these longer durations have on a child's oral health. As such, a second question to be addressed is whether an increase in the duration between visits is correlated with worse dental outcomes defined as an increase in emergency visits and dental caries. It is tradition that children see the dentist every six months, but this may not be necessary. As detailed in the preceding chapter, there is no published clinical evidence supporting the need for universal six-month check-ups for children. As such, this research will provide some empirical evidence to support or refute the current policy. It is hypothesized that longer durations between check-ups correlate with an increase in dental caries and emergency visits. Additionally, children are divided into high risk for dental caries and low risk for dental caries. Children who had a carie in the previous year were considered high risk for getting additional caries, it is hypothesized that children identified as high risk may have shorter durations between check up visits.

### 3.3 Study Population

All children under the age of 13 are eligible for coverage under the DHP. Thus, in order to be included in the study an individual must be less than 13 years of age, reside in the province of Newfoundland and Labrador and have had a dental visit between 1996

and 2005. An individual's date of birth can be extracted from the MCP (Personal Identification Number: PIN), and from this information the date an individual turned 13 was computed. Once an individual had their 13th birthday they were removed from the analysis as their coverage under the dental plan changed.

Including all records of children eligible under the plan provides a comprehensive picture of dental usage in this population. Individual visits to dentists from 1996 through 2005 are used in this analysis. In the initial part of the analysis where a duration model is used, only individuals who had at least one maintenance visit are included. The reason for this inclusion is that the maintenance visit is the point of origin used in the duration model and the length of time between visits is counted from one maintenance visit to the next. The second part of the analysis measures the incidences of emergency visits and caries. The construction of these databases are explained in more detail below.

### 3.4 Measures

In order to successfully fulfill the study's objectives as outlined in chapter one, four types of measures were considered. These include usage of the dental plan, socioeconomic status, fee difference and demographics. The first objective of the study is to assess the patterns of utilization of the dental plan across time and between socioeconomic groups. This requires the use of variables that measure usage of the plan and socioeconomic status.

Utilization of the DHP can be measured in several ways including cleanings, fluoride treatment and check-ups. These procedures are included in a maintenance visit.[2]

[2] confirmed by personal communication with Dr. Williams who is the dental consultant at the Newfoundland and Labrador Department of Health and Community Services (NL DoHCS)

Thus, these three procedures were collapsed into one record and represent a maintenance visit.

The second objective is to examine trends between socioeconomic status groups and overall utilization of the DHP over time, which requires a SES variable. The third objective is to examine if the durations between dental visits became longer as the fee difference increased. The fourth objective to assess if longer durations result in increases in emergency visits or dental caries. The final objective is if children identified as high risk e.g those that had a dental carie in the previous year have duration differences from the low risk group ie. children who did not have a carie in the previous year. The cost of the dental procedure was calculated using the Newfoundland and Labrador Dental Association's Fee Guides from 1996 to 2005, which provides the recommended amount for a dentist to charge. A list of fluoride, cleaning and check-up fee changes from 1996 to 2005 will be presented in Table 3.2.

If there is a longer duration between visits, the final objective is to assess if longer durations have any effect on a child's oral health. A shorter duration does not necessarily mean health is better; we are trying to determine if there are any adverse health outcomes if durations between maintenance visits lengthened. There are two variables used to assess a decline in oral health: the incidence of dental caries and emergency visits. The two variables are coded in the database, thus it is easy to track changes in the number of caries and emergency visits. There are random audits completed by Newfoundland and Labrador Department of Health and Community Services (NL DoHCS) to ensure the FFS code matches the procedure performed by dentists; these audits are done by contacting the patient's/patient's parents for verification that a procedure was done on specific dates.

### 3.4.1 Data Sources

In order to achieve the study's objectives, information was extracted from several different databases. Primarily, the Newfoundland and Labrador MCP supplied data; secondary data sources were the Canadian Census, a Postal Code Conversion File, and the Newfoundland and Labrador Dental Association's Fee Guides and list of practitioners. The MCP records contain administrative information about health care and dental care, most of which were not relevant to this research study. To simplify the database, claims and variables of interest were selected from the original MCP database and placed into a condensed database by the NL DoHCS. The MCP database contains a record of each dental visit for children between the ages of 0 to 12 years old; this information is extracted from the personal identification number (PIN), which is one of the components in the MCP database. This age group was separated from all other records in the database as they share the same oral health care coverage under the DHP. Regardless of socioeconomic status, each child is entitled to a subsidized biannual check up and an annual cleaning.

The Canadian Census was used to supply population figures. Additionally, it provided socioeconomic information and categorized Newfoundland and Labrador into 10 Census Divisions (CD). The Postal Code Conversion File was used to link an individual in the MCP database to the socioeconomic data obtained from the Canadian Census by allowing for the linking of each post code on the MCP file to be assigned a Dissemination Area (DA). Additionally, the Postal Code Conversion File attached an individual's post code found in their MCP record to a CD which provides a broad-based

geographic locator. Service availability was included as it may impact duration times between dental check-ups.

A limitation is postal codes are assigned when the MCP card is issued, thus when a person relocates we are not able to capture it. If a person notifies MCP they have moved it is updated in the MCP database and these individuals would be reassigned to a new DA and CD. However, if they do not notify MCP the postal code remains unchanged in the database.

In the next phase of the study a database was created for each year of study from 1996-2005. The database contained dental records from January 1st, 1996 to December 31, 2005. Each record in the database represents one maintenance visit and may include some combination of a check-up, cleaning and/or fluoride treatment. Any combination of these three procedures will be considered a maintenance visit. The variables used in the study are described in the following section, along with the data source, its purpose and its importance to the study. Additionally, the procedures done to each variable to prepare it for analysis are also described below.

### 3.4.2 Variables and Manipulations

**Variable: PIN**

In the MCP database, data are individual specific and it is possible to track a person's dental heath care utilization across time. Each record contains a unique number, which identifies an individual to a central file containing the individual's personal information such as their name.

The PIN contains a string of twelve numbers, the first two and last three are

randomly assigned and are unique for each person. The third to the ninth digits contain a person's year of birth, birth date on the Julian calendar and their gender. As an example, the MCP number 889833657809 can tell us a person's birth year by looking at the third to fifth digit of the pin. In this case the number is 983; this means the person was born in 1983. The sixth to eighth digits, 365, is the person's birthday on the Julian calendar and in the above example the person was born on the 31st day in the month of December. The last digit represents the gender of the individual, a value between 0-4 means the person is a male and 5-9 represents a female. In the above example, the value is 9 indicating the individual is female.

In allowing for the extraction of a date of birth, the PIN allows for the identification of the target group: children who have not celebrated their $13^{th}$ birthday. As mentioned earlier, until the age of 13 each child in Newfoundland and Labrador receives the same coverage under the DHP, which is a biannual check up, and annual cleaning. Billings for such services are done through the MCP database. After the age of 13, only adolescents identified as low income (i.e. their parents are recipients of social assistance) are eligible for the biannual check-up and annual cleaning. Procedures preformed on these will be in the MCP database as dentists continue to submit such billing information. However, the remainder of adolescents in Newfoundland and Labrador cannot be accounted for past the age of 13, as a dentist would now directly bill to a third party insurance plan (such as Blue Cross Atlantic) or to the parents. Therefore, no adolescents are included in the analysis and as soon as a child turned 13 they were removed from the data set.

In the database, a child's PIN correspond exclusively to dental procedures. If a

child were to visit a dentist for a check-up, the dentist would submit a bill to MCP indicating what procedures were performed, where they were performed and when they were performed. Dental visits are coded according to procedure (FFS), thus we can keep track of how many maintenance visits an individual had during the study period and at which intervals. Additionally, there is a procedure code for emergency visits and dental caries. These procedure codes make it possible to assess if a child has longer durations between check-ups, are they more likely to experience dental caries and/or emergency visits.

The PIN is also attached to the person specific postal code used to measure an individual's socioeconomic score by linking the postal code to a dissemination area (DA). However, all other information that is person specific, such as names and full addresses, were removed from the database before it was supplied by NL DoHCS.

**Variable: Service Date and Time between Maintenance Visits**

The variable service date represents the date a dental procedure took place. The purpose of using the service date is to track an individual's usage of the dental plan over time as the fee differential increased. By tracking the service dates of maintenance procedures over time one can determine if the number of services a person undergoes declined. Since the fee difference increased for each year in the study, it is expected that the time between service dates for an individual will become longer.

The time between visits variable represents how many days have elapsed between dental maintenance visits. As such, all dental visits for caries and emergency visits were not included in the computation of time between visits. The reason for this is we are interested in utilization of the dental plan, which provides subsidized coverage for

biannual check-ups and annual cleanings. Therefore, it is only necessary to measure the elapsed time between two maintenance visits, which can be calculated directly from the service date (see below).

**Manipulation: Service Date**

The PIN is attached to the service date an individual receives a dental procedure. The service date is given by day/month/year requiring a conversion to incorporate it in STATA. The service date plays an integral part in determining the impact of an increasing fee difference on duration times between dental check-ups. Additionally, a program needed to be created in STATA to ensure that once a subject was no longer covered by MCP (subject's 13th birthday) they would be dropped from the analysis.

The statistical program STATA was used to convert the service date into a count of elapsed time. The program uses an arbitrary date of Jan. 1st, 1960 to represent day 1 of the count. The data set began on Jan. 1st, 1996, which is day 13,149 in elapsed time (i.e. 13,149 days since the 1st of January, 1960). The service date of each procedure was converted into elapsed days. Converting the service date into elapsed days made it possible to calculate the duration (measured in days) between maintenance visits for each individual over the observation period. Comparing adjacent records and calculating the duration in elapsed time between two maintenance visits allows for computation of time between maintenance visits. This allows for a straightforward examination of how the durations between visits changed as the DHP became relatively less generous and also for a comparison of how utilization varies across defined socioeconomic groups. Further discussion of the statistical treatment of durations will be provided in Chapter 4.

**Variable: Fee code**

Fee codes are linked to specific dental procedures with different billing amounts. As such they allow for the identification of procedures performed and the amount claimed for MCP by the dentist for each procedure performed. When a child visits the dentist, the dentist will send the corresponding claim to MCP. When linked longitudinally using the PIN, these fee codes track a child's utilization of the DHP and, more specifically, allow for the reconstruction of each individual's DHP utlization history. For instance, a child could go to the dentist for a regular check-up, which is captured by the fee code 8631100 corresponding to the fee procedure DIAGNOSTIC EXAMS - LIMITED ORAL (RECALL PATIENT). We may continue to see this child's PIN number, but that does not mean they are necessarily using the DHP for a check-up or cleaning. For instance, a child's PIN may be showing up more frequently in the database due to an increase in emergency visits and/or dental caries. By using the variable fee code it is possible to determine if they experience more caries or emergency visits, as the fee codes for such procedures are distinct from check ups and cleanings. A list of fee codes and the frequency in which they appear in the MCP database is supplied in Table 3.1.

**Table 3.1**

## Percentage of Fee Code from 1996-2005

| Fee Code Number | Fee Code Procedure | Percentage of Dentists' Claims |
|---|---|---|
| 861100 | DIAGNOSTIC EXAMS - LIMITED ORAL (RECALL PATIENT) | 26.2 |
| 863500 | PROPHYLAXIS - PRIMARY DENTITION | 12.5 |
| 863550 | FLUORIDE TOPICAL (NOT SELF ADMINISTERED) | 11.1 |
| 864300 | RESTORATION - PRIMARY - TWO SURFACE | 5.5 |
| 861150 | DIAGNOSTIC EXAMS - EMERGENCY (REMARKS CODE REQUIRED) | 5.1 |
| 866000 | SINGLE EXTRACTION, UNCOMPLICATED | 4.7 |
| 865000 | RESTORATION - PERMANENT MOLAR - ONE SURFACE | 4.1 |
| 861110 | DIAGNOSTIC EXAMS - LIMITED ORAL (NEW PATIENT) | 3.8 |
| 862100 | RADIOGRAPHS - BITEWING - TWO ( AT 2-YEAR INTERVALS) | 3.4 |
| 864200 | RESTORATIONS - PRIMARY - ONE SURFACE | 2.8 |
| 866150 | EXTRACTION - SINGLE, FOR SOCIAL ASSISTANCE RECEPIENTS 13 YEARS AND OLDER | 2.6 |
| 865100 | RESTORATION - PERMANENT MOLAR - TWO SURFACE | 2.3 |
| 862400 | RADIOGRAPHS - PERIAPICAL - ONE (REMARKS CODE REQUIRED) | 2.0 |
| 866160 | EXTRACTION - EACH ADDITIONAL - FOR SOCIAL SERVICE RECEPIENTS 13 YRS. AND OLDER | 2.0 |
| 863510 | PROPHYLAXIS - MIXED DENTITION | 1.9 |
| 866100 | REMOVAL - EACH ADDITIONAL TOOTH, SAME QUADRANT | 1.4 |
| 867700 | PULPOTOMY + FINAL FILLING THE SAME DAY | 1.2 |
| 864300 | RESTORATION - PRIMARY - TWO SURFACE | 1.2 |
| 865500 | RETENTIVE PINS (NO CO-PAYMENT) - ONE PIN | 0.9 |
| 864000 | REMOVAL OF CARIOUS LESION OR EXISTING RESTORATION AND PLACEMENT OF SEDATIVE/PROTECTIVE DRESSING | 0.7 |
| 864400 | RESTORATION - PRIMARY - THREE SURFACE | 0.7 |
| 864700 | RESTORATION - PERMANENT ANTERIORS AND PREMOLARS TWO SURFACE | 0.5 |
| 866200 | ODONTECTOMY, SURGICAL APPROACH, REQUIRING SURGICAL FLAP AND OR SECTIONING OF TOOTH. (EXCEPT THIRD MOLAR IMPACTIONS) | 0.4 |
| 865200 | RESTORATION - PERMANENT MOLAR - THREE SURFACE | 0.4 |
| 863520 | PROPHYLAXIS - PERMANENT DENTITION | 0.4 |
| 862500 | RADIOGRAPHS - PERIAPICAL - TWO (REMARKS CODE REQUIRED) | 0.4 |
| 864500 | RESTORATION - PRIMARY - FOUR OR MORE SURFACES | 0.3 |

The fee codes classified as maintenance visits are 861100: check up, 861110: diagnosis for a new patient, 863550: topical fluoride treatment, and 863500: cleaning.

**Manipulation: Fee Codes**

The MCP database contains different fee codes than those listed in the Newfoundland and Labrador Dental Association's Fee Guides. In order to amend this problem, the NL DoHCS provided a data dictionary on the MCP database. The description of what each fee code represents was compared to the fee code description found in the Fee Guides. It should be noted that the fee codes from the NLDA were matched to the fee codes found in the MCP. To ensure this was done accurately, the NL DoHCS dental consultant confirmed the matches. It was important to align the fee codes in both data sources as they are linked to the recommended amount a dental practitioner should charge for a procedure, which in turn, is necessary to calculate the fee differential.

**Variable: Maintenance Visit**

The variable maintenance visit is a record for when an individual visited the dentist for a check-up, fluoride treatment, or cleaning on the same day and represents any combination of these procedures. As such, the maintenance visit is good way to measure utilization of the dental plan, as there are specific fee codes for these procedures that dental providers submit to MCP for payment.

**Manipulation: Maintenance Visit**

A check up visit, fluoride treatment, and cleaning all generate separate records in

the MCP database even when all these procedures occur on the same visit. As such, these procedures were deemed to constitute a maintenance visit, which was confirmed by the NL DoHCS dental consultant. To simplify the database, when these procedures were done on the same date, the records were collapsed into one record and labeled a maintenance visit. There were 589,665 records representing maintenance visits between January 1st, 1996 and December 31st, 2005 for our defined population of children aged 12 and under.

**Variable: Fee Difference**

The amount billed to MCP for all procedures and the NLDA recommended fee are tallied so that both are captured in cumulative form. These figures were available for the 10-years of the study and were used, in part, to calculate the fee difference by year. The difference between what the NLDA recommended for any given year and the amount paid by MCP are combined such that the differential represents the total fees that should have been billed and the MCP amount paid for all services performed during that visit. The main hypothesis to be tested is that as the fee difference increases it negatively impacts utilization of the DHP. Table 3.2 shows the fee increases in the cost of maintenance procedures (fluoride, cleaning and check up) from 1996 to 2005 as recommended by the NLDA. The fee code 861100 represents a recall diagnostic exam for patients and 861110 represent a diagnostic exam for a new dental patient; both are more commonly known as a check up visit. The fee code 863500 represents prophylaxis which is a cleaning and 863550 is a fluoride treatment. Additionally, table 3.3 shows the average difference of all maintenance procedures by year from 1996 to 2005.

**Table 3.2**

**Cost of Maintenance Procedures in Dollars, by Year**

| Procedure[3] | Year | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1996** | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** |
| **Check up** | 26.98 | 27.53 | 28.08 | 28.92 | 29.36 | 30.2 | 31.11 | 29.81 | 29.81 | 29.81 |
| **Diagnostic** | 20.24 | 20.65 | 21.06 | 21.69 | 22.02 | 22.66 | 23.34 | 25.85 | 26.26 | 26.62 |
| **Cleaning** | 23.61 | 24.09 | 24.57 | 25.31 | 25.69 | 26.44 | 27.22 | 27.22 | 27.66 | 27.66 |
| **Fluoride** | 11.79 | 12.04 | 12.29 | 12.65 | 12.85 | 13.22 | 13.61 | 15.34 | 15.59 | 16.08 |

**Table 3.3**

**Average Fee Differential by Year for all Maintenance Procedures**

| Year | Fee ($) |
|---|---|
| 1996 | 4.85 |
| 1997 | 5.30 |
| 1998 | 6.02 |
| 1999 | 7.20 |
| 2000 | 7.69 |
| 2001 | 8.85 |
| 2002 | 9.99 |
| 2003 | 12.62 |
| 2004 | 13.37 |
| 2005 | 13.84 |

[3] Fee code 8631100= Check up; 861110=Dignostic; 863500=Cleaning; 863550=Fluoride

**Manipulations: Fee Difference**

Part of the study's objective is to assess if an increasing fee difference impacts utilization of the DHP. The fee difference needed to be calculated for each year as NLDA guidelines for suggested fees change each year. Once this step was completed, the cost of a dental procedure by year was created in a separate file. The dental subsidy was frozen in 1995, thus the amount of coverage for dental procedures remained constant during the study period. As the only changing variable is the cost of the dental procedures, the fee difference was easy to calculate.

**Variable: Socioeconomic Score**

As noted earlier, each record in the MCP database contains an individual-specific postal code. These postal codes were linked to the Census and subsequently converted into a meaningful socioeconomic status (SES) indicator. The SES measure was derived by Audas et al. (51), in which they created a SES score for each post code by linking it to a DA and calculating a SES score for each DA by using the 2001 Census. The 2001 Census was used, as it was the latest available Census at the time of this study. Audas et al. (51) used 13 indicators to compute a measure of SES for each DA:

- the proportion of the labor force in high-status occupations;
- the proportion of the population holding a university degree;
- the proportion of the population having less than a high school diploma;
- average income;
- the proportion of 15 to 24-year-olds not participating in education;
- average home value;

- average rent;
- the proportion of one-parent families;
- the employment rate for adults;
- the unemployment rate for adults;
- the employment rate for youths aged 15 to 24;
- the unemployment rate for youths aged 15 to 24: and
- the proportion of households classified as 'low income'.

These 13 factors provide a general indication of SES for each DA. Each person's postal code in the MCP database is linked to a DA using the Postal Code Conversion File. The purpose of using a SES is to determine if dental care plan use varies across socioeconomic grouping and to see if differences between these groups changes as the fee differential increases. A key hypothesis in this thesis is if families have to pay a greater share of their dental costs, utilization rates are more likely to decline in the low SES groups.

**Manipulation: Socioeconomic Score**

The dental health care data was divided into quintiles and deciles for analytical purposes. The quintiles divide the population into approximately 5 equal groups according to their SES while the deciles divide the population into approximately ten equal groups according to the same criteria. The postcodes were ranked based on the SES score and divided into quintiles, and deciles.

When there was an overlap of a single postal code in multiple DA's a simple average of the SES in each DA within that postal code was calculated. A limitation is

some individuals were not assigned a SES due to missing postal codes in the database; hence they were subsequently missing from a quintile or decile. Records that could not be assigned a SES were removed from the database prior to the analysis. The proportion of cases where this occurs is less than 1%, suggesting no major introduction of bias.

**Variable: Socioeconomic Status and Fee Difference**

SES is based on 13 indicators (51), which are described above. The fee difference is the difference between the NLDA recommended amount and the amount paid by MCP. The interaction between SES deciles is important as it allows for the assessment of whether particular (i.e. low) SES groups were more adversely affected by the freeze in the subsidy.

**Variable: Census Divisions**

Census Divisions (CD) are a four-digit code assigned to ten areas within Newfoundland and Labrador. Appendix 2 provides a map of the main communities found within each of the CD in Newfoundland and Labrador. The purpose for using CD is to determine if there are geographical differences in the duration between visits varies based on location. The postal code is linked to a CD using the Post Code conversion file. The variable postal code is linked to a child's PIN number; if a child moved from 1996 to 2005 the PIN stays the same but the postal code information is updated in the MCP database if MCP is notified of the move. If an updated postal code is provided to MCP it will be changed in the system and SES would move accordingly. However, there is no way to capture the reliability of updated postal codes. For instance, a person's postal code may only change in the MCP system when they apply for a new card. However, in

the interim it is not possible to capture how many times they moved.

**Manipulations: Census Divisions**

The Postal Code conversion file works by taking all the postal codes found in the dental health database and attaching them to a DA then aggregating these up to larger geographies, with Census Divisions (CD) being the largest standard aggregation within each province. The province is divided into ten CDs with each individual's postal code in the database assigned to a CD. However, in a few cases there were postal codes that fell into more than one CD. If a single postal code overlapped multiple CDs, it was assigned to the CD where the majority of similar postal codes fell. For instance, if A0E1J7 overlapped CD 1 (coded in Canadian Census 1001) and CD 2 (coded in Canadian Census 1002), it would be assigned to the CD where the majority of identical postal codes were found. This occurs because postal codes, particularly in rural areas may represent quite large areas and thus may span multiple DAs and CDs. Some records could not be assigned to a CD due to missing postal codes in the Post Code Conversion File. Records with missing postal codes were not included in the final analysis.

**Variable: Persons per Dentist**

A list of dental providers and their addresses was supplied by the NLDA for each year between 1997 and 2005; 1996 was excluded, as the NLDA did not produce a list of dental providers for this year. The Postal Code Conversion File is used to link a dentist's postal code to a CD. The number of dental providers in a CD was calculated by individually assigning a dentist to a CD based on their postal code. This allows us to

create a ratio of persons per dentist for each CD for each year.

The information was collected to allow us to link a person to the availability of dental providers in their area. The variable person_per_dentist was used to assess if longer durations were in part, due to lack of dental services available. Table 3.4 shows the persons per dentist by CD and year. Persons per dentist were calculated by dividing the total population in a CD by the number of practicing dentists in that CD. Population figures for each CD were obtained from the 1996 and 2001 and 2006 Canadian Census; population projections were done for the remaining years.

**Table 3.4**

**Persons per Dentist by Year and CD**

| Year/CD | 1001 | 1002 | 1003 | 1004 | 1005 | 1006 | 1007 | 1008 | 1009 | 1010 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1997 | 3287 | 27053 | 22459 | 8097 | 2646 | 2753 | 20347 | 23518 | 11151 | 14199 |
| 1998 | 3101 | 8794 | 21223 | 7920 | 2433 | 2531 | 7971 | 15274 | 3625 | 2761 |
| 1999 | 3041 | 25713 | 20605 | 5807 | 2935 | 3114 | 19507 | 22306 | 4239 | 2979 |
| 2000 | 2878 | 25043 | 19987 | 5674 | 3398 | 2452 | 19087 | 14466 | 2949 | 2602 |
| 2001 | 2824 | 24371 | 19370 | 5541 | 1847 | 2529 | 36208 | 18668 | 3349 | 3154 |
| 2002 | 2835 | 23886 | 19089 | 4399 | 3377 | 3017 | [4]37029 | 13882 | 3951 | 2574 |
| 2003 | 2719 | [5]7824 | 18808 | 4366 | 3382 | 2414 | 7345 | 13701 | 3237 | 2067 |
| 2004 | 2623 | 7547 | 18246 | 4300 | 3130 | 1810 | 7223 | 13340 | 3750 | 2216 |
| 2005 | 2605 | 11113 | 8983 | 4266 | 3135 | 1906 | 11936 | 39478 | 3069 | 2014 |

Appendix 1 provides a detailed list of the communities in which a dentist

[4] Large change between 2002-2003 in CD 1007 is due to dentists leaving the area.
[5] Large change between 2002-2003 in CD 1002 is due to an inflow of dentisits to the area.

practices, and their postal code. Appendix 2 provides a Map of Newfoundland and Labrador divided into CDs and shows the main community in each CD. For instance, if a dentist practices in the community of Gander then one can look at the map and determine they are in CD 6.

The person per dentist ratio was included in the dataset to statistically control for provider availability. It may be that in areas where there are relatively few available dentists, individuals have to wait longer to obtain dental care, which would influence the length of time between dental visits.

**Manipulations: Persons per Dentist**

The person per dentist ratio is the number of persons per dentist in a CD; this was calculated by dividing the population of a CD by the number of dentists practicing in a CD in a given year. It should be noted that the population figures for each CD in 1996 and 2001 and 2006 are based on the Canadian Census. However, population projections were done for the years in between by taking the total population change between 1996 and 2001 and dividing by 5. For example, the population in CD 1001 in 1996 was 251, 523 and in 2001 it had declined to 242, 875. The difference between these two numbers is 1,730, since there is a declining population the 1, 730 was subtracted from the 1996 figure (242, 875) to project the population in 1997 (249, 793). Population projections from 2001 to 2005 were done in the same way. Appendix 3 contains the figures for these projections.

**Variable: Emergency Visits**

The variable emergency visit is a record captured when a child visits the dentist for an emergency visit. The specific code for emergency visits in the MCP database is 861150. Emergency visits are used as outcome measures to assess the impact longer durations have on a child's dental health. It was hypothesized that as the length of durations became longer there will be an increase in the number of emergency visits.

**Manipulations: Emergency Visits in Previous Year**

A separate file was created within the data set to capture emergency visits; children were divided into two groups, 0= no emergency visits in the previous year and 1=yes, they had a emergency visit in the previous year. January 1$^{st}$ to December 31$^{st}$ 1996 was used as a washout period, which is needed to serve as our study's baseline. For instance, in 1997 we can look at the 1996 data and determine if an individual child had a emergency visit in the previous year.

**Variable: Caries in Previous Year**

The variable caries in previous year is a record capturing when a child visits the dentist for caries. There are several fee codes for dental caries, which differ, based on the number of caries and the caries location on the tooth and in the mouth. For instance, 864200, 864300, 86400 and 864500 all represent dental caries. This variable is introduced as a way to separate children at high risk for getting dental caries from those at low risk and determine if risk impacts duration times. It is hypothesized that a child with caries in the previous year (high risk) will have short duration times between dental

check-ups in comparison to children with no caries in the previous year (low risk).

**Manipulations: Caries in Previous Year**

The dental data had a separate file with records of caries; children were divided into two groups, 0= no caries in the previous year and 1=yes, they had a carie in the previous year. January 1st to December 31st 1996 was used as a washout period, which is needed to serve as our study's baseline. For instance, in 1997 we can look at the 1996 data and determine if an individual child had a carie in the previous year. The variable allows us to categorize individuals as high/low risk.

# Chapter 4: Methods

## 4.0 Overview

The methodology is a plan for collecting; organizing and integrating collected data so that an end result can be reached (59). To examine the impact of freezing the dental subsidy on maintenance visits, a duration model was used. In the following sections details on duration models will be provided, along with an explanation of why a duration model was used to measure the time between dental visits. Particular attention is given to the usefulness of a frailty duration model.

## 4.1 Introduction

The main objective of the study is to assess changes in utilization of the dental plan from1996 to 2005 as fees under the DHP were frozen, leading to an increase in out of pocket costs for children's dental care. By freezing the subsidy, the government reduced expenditures, but a trade off is that parents may have decided to take their children to the dentist less frequently. This may have a negative impact on oral health leading to an increase in dental caries and emergency visits.

As noted earlier, under the DHP children under 13 are entitled to a biannual check-up. Thus, it appears reasonable to use the frequency of check-ups as the measure to assess changes in utilization. However, a simple count of check-ups over time is not a useful measuring tool, as the number of children visiting dentists each year also changes as a result of population changes within the province. It makes more sense to use a model that focuses on the length of time between dental visits rather than the overall

changes in frequency of dental check-ups. To assess the length of time between dental visits, a duration model was used. Duration models are also referred to as survival or hazard models and they assess how different factors influence the duration of some particular event: in this case, time between dental maintenance visits. To examine the impact of the fee differential, the computed difference between the NLDA recommended price and the amount paid by MCP was included as an independent variable in the regression model. In addition, socioeconomic deciles and interactions between these deciles and the annual fee differences were included in the model to assess if the fee differential had a larger impact on lower socioeconomic groups; i.e. were children from less affluent families waiting longer for maintenance visits as the cost to visit a dentist increased? This was examined by interacting the SES deciles variable with the fee differential.

The duration model also included persons per dentist in a given CD, age, gender, dummy variables for each CD, and dummy variables for each year measured at the service date when the spell ended. The latter are particularly important in this context because, in conjunction with the fee differential variable, they allow us to assess the impact of the freeze in the DHP subsidy independent from any secular changes in dental health practices.

**4.2 Duration Models**

A duration model is the most appropriate statistical technique for this analysis as it examines the time between events. In this study, we are interested in the amount of time between dental maintenance visits. The duration model was originally designed in

the field of biostatistics to follow the surivial of patients. However, today duration models are used in a wide range of fields. In order for researchers to use a duration model there are three pieces of information needed: a time point when an individual began the spell; a time scale in hours or days or months to measure the length of the spell; and, a precise definition of events that indicate the end of the spell. For this study, the time point when an individual comes under observation was the date of their first observed maintenance visit. The time scale used to measure the length of time between dental visits is elapsed days, which has been explained in detail in the previous chapter (3.4.1 Manipulations: Service Date and Time between Visits). After the initial observation, each subsequent maintenance visit is simultaneously the end of the previous spell and the beginning of a new spell. Individuals contribute durations until they turn 13 years old or cancel their MCP number, indicating that the individual left the province.

In computing the duration between check-ups, it was relatively easy to identify when a spell began as we had access to data on all dental visits. However, there were many cases when there were no observations of a spell ending. When a person is not observed ending a spell in the database this is called "right censored". Many techniques were employed to ensure that spells were truly right censored. Initially, an indication was made when the spell ended as a result of a child turning 13 years old. Next, the censored records were cross-referenced with a list of deleted PINS and the dates of deletion. Duration models are excellent to use when information is right censored because it allows flexible ways to measure the length of time between dental visits. If least squares regression models were used there would be biased estimations as they do not accommodate censored data and exclude it from the analysis. Furthermore, Kiefer

(55) states that the probability of exiting the spell, which in this study is most likely due to another check-up visit, depends on how long the individual has been in that spell. This is referred to as 'duration dependence'. For this study considering time between dental check-ups, it is likely that spells between maintenance visits will end in short durations if the person has a regular check-up regime. Kiefer (55) argues the conditional probability of an individual's spell ending is not constant over time. Thus a regression technique, which is not able to handle data in this form, makes it less useful for modeling durations.

The principle objective of duration models is to examine the impact of various factors on the length of time between events: in this case, maintenance visits. In the construction of this database we use a duration regression where values are linked to the end of the spell. This means that the individual characteristics, the fee differential, and the population per dentist are all measured at the point in time when the spell ends (i.e. when the individual had a maintenance visit).

The duration results are expressed as hazard ratios. Hazard ratios are centered on 1, so a variable with a hazard ratio of 1 has no impact on the duration of the spell. Hazard ratios greater than 1 means a variable is assoicated with a duration ending more rapidly and a hazard ratio of less than 1 is associated with a longer lasting duration.

### 4.3 Frailty Models

Conventional duration models assume homogeneity, meaning that in a population all the individual subjects are influenced by the same risks. Thus, they do not take unobservable individual differences into account. For example, if two individuals are grouped according to SES and the length of time between visits is observed, the results

will be generalized to the whole socioeconomic group (same risk) regardless of the fact that these two individuals may have completely different dental health care practices and needs. However, the purpose of the analysis is to assess the same individuals under varying circumstances over a 10-year period. When we cannot directly observe all factors that make individuals unique it is known as unobserved heterogeneity or "frailty" when used in a duration model. Frailty can be controlled by assessing multiple observations for the same person over time, since this allows us to observe the same individual (and all his or her observable and unobservable characteristics) under different circumstances. As such it will provide a more accurate assessment of the impact of the increasing fee differential on each individual's personal dental practices (i.e. going for maintenance visits) and assess if there are differences across socioeconomic status groups. This approach effectively allows the researcher to statistically control for important unobserved differences across individuals and to estimate the impact of the decline of the dental health subsidy on utilization.

In addition the 'shared' option is specificied and observations are linked with their unique identifiers to effectively control for clustering in the data, which will be present since individuals in most cases contribute more than one observation to the dataset.

The main duration regression results were produced using STATA software ($11^{th}$ edition) using the survival time regression ('streg') function.[6] A more complete discussion of the 'streg' function can be found in STATA – Release 11, 'Survival Analysis and Epidemiological Tables' pages 195-238.

[6] In the duration model the frailty is assumed to be inverse gaussian and the hazard model is assumed to follow a weibull distribution. Other frality and hazard distributions were estimated. These did not reveal any major deivation in the variables of interest.

**4.4 Incidences of Emergency Visits and Caries**

If it is established that utilization has declined over the observation period, we would want to examine whether these longer durations have resulted in more adverse dental outcomes. Given that in many cases emergency visits and caries are preventable, one might expect that as young people receive less dental maintenance, they become more susceptible to adverse outcomes captured by caries and emergency visits in this analysis.

The incidence rates were measured as the proportion of the spells since last maintenance visits that ended in emergency visits or caries. This was done for two reasons. First, it is not possible to get an accurate estimate of the number of the children under 13 years old in Newfoundland and Labrador for all years. For instance, the 1996 and 2001 Canadian Census provides information on the number of children under the age of 14 residing in Newfoundland and Labrador. However, it does not provide a break down of population by year. Furthermore the 2006 Canadian Census has only released limited information, meaning precise age specific estimates of the population are not available for all years. The Newfoundland and Labrador Statistics Agency maintains a database called the Community Accounts that has detailed information on each community within Newfoundland and Labrador. However, it did not have a projection of the age-specific population after 2001. Since the population of Newfoundland and Labrador has been unstable due to changing birth rates and out migration it is not possible to obtain an accurate picture of the number of children under the age of 13 for each year to allow the calculation of an incidence rate. Second, a purpose of this study is to assess the effect of SES on the incidences of caries and emergency visits. For both of

these reasons the only way to accurately calculate the incidence rate was to link it back to the postal codes in the MCP records.

### 4.5 Conclusion

A frailty duration model was used to address the first key research question in the study: did an increasing fee differential make individuals less likely to receive maintenance dental care? The frailty approach was used to provide a more accurate picture on how the fee differential impacted individuals' personal dental health care practices. The use of a multivariate frailty model can also simultaneously demonstrate the impact the fee differential has across socioeconomic groups to determine if particular groups were especially affected by freezing the subsidy.

# Chapter 5: Results

## 5.0 Introduction

The main objective of this chapter is to examine whether increasing the required co-payment (which resulted from freezing the subsidy and increasing the amounts charged by practitioners) led to children aged 13 and under having fewer dental visits for maintenance procedures. A secondary objective is to examine the relationship between SES and durations, with a particular focus on examining whether individuals in lower socioeconomic groups tended to take more time between routine dental visits than their more affluent counterparts as families were required to shoulder an increasing share of the costs of dental care.

Following this, the analysis will focus on two indicators of oral health care: emergency visits and dental caries. As the duration between maintenance visits increases, examining the incidences of dental caries and emergency visits indicates the impact it has on a person's oral health. To examine if low SES families were particularly affected, the incidence of dental caries and emergency visits will also be assessed across socioeconomic quintiles.

## 5.1 Overall Patterns of DHP Utilization by Children in Newfoundland and Labrador

We began by examining the overall utilization figures for the observation period. By doing a simple count it appears there is a decreasing trend over time in dental visits. As shown in Table 5.1, there were 65, 902 dental visits by children under the age of 13 in 1996. By 2005 this number has dropped to 47,285. These results show there was a

decline of 18,617 (28.3%) visits over the 10 -year period. However, these results may not tell the whole story, as they fail to take into account the population changes in Newfoundland and Labrador such as a shifting demographics and out migration. When one does not takes into account population changes it is difficult to determine if the decline in frequency of dental visits was due to individuals having fewer visits or whether fewer children are seen in the dental health care system simply because there are fewer children in the province.

**Table 5.1**

**Number of Children's Dental records reimbursed under the DHP from 1996- 2005**

| Year | Frequency |
|---|---|
| 1996 | **65,902** |
| 1997 | 62,780 |
| 1998 | 59,945 |
| 1999 | 58,437 |
| 2000 | 57,276 |
| 2001 | 55,912 |
| 2002 | 53,066 |
| 2003 | 50,973 |
| 2004 | 49,143 |
| 2005 | **47,285** |
| Total Difference from 1996 to 2005 | 18,617 |

## 5.2 Overall Patterns of DHP Utilization by Children across Socioeconomic Groups in Newfoundland and Labrador

The relationship between SES and utilization of the DHP was examined for each year between 1996 and 2005. The 2006 data was available up to August 31st, thus the number of check-up records is drastically lower in 2006 compared to 2005 as it covers a shorter time period. Due to this reason, the 2006 data were excluded from the analysis. SES was divided into 10 equal blocks of distribution; in which decile 0 represents the poorest individuals and decile 9 represent the wealthiest. It should be noted that the decile breakdowns were done prior to merging with the MCP data. This is important because it reflects the total population and allows for a rebalancing based on socioeconomic mobility. All socioeconomic groups experienced a decline in usage of the DHP as seen in Table 5.2. However, SES10 and SES90 experienced the greatest absolute decline in check-ups between 1996 and 2005; SES10 declined by 3,359 (32.5 %) and SES90 declined by 3,483 (30.3%). An additional explanation for such changes in these socioeconomic groups is that over the observation period the number of less affluent and affluent families in the province also declined causing a more economically balanced population in the province.

**Table 5.2**

**Check up records by Year and SES Deciles**

| Year/Decile | 00 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 4,969 | 10,345 | 5,688 | 4,792 | 5,616 | 6,371 | 6,802 | 6,561 | 8,225 | 11,502 |
| 1997 | 4,629 | 9,804 | 5,385 | 4,662 | 5,317 | 6,103 | 6,412 | 6,362 | 8,225 | 10,901 |
| 1998 | 4,399 | 9,419 | 5,212 | 4,588 | 5,169 | 5,725 | 6,145 | 5,873 | 7,423 | 10,391 |
| 1999 | 4,225 | 9,212 | 5,004 | 4,334 | 4,960 | 5,671 | 6,150 | 5,735 | 7,431 | 9,940 |
| 2000 | 4,096 | 8,923 | 4,903 | 4,290 | 4,960 | 5,544 | 6,166 | 5,576 | 7,251 | 9,663 |
| 2001 | 3,990 | 8,604 | 4,700 | 4,209 | 4,947 | 5,350 | 6,095 | 5,677 | 6,980 | 9,350 |
| 2002 | 3,617 | 7,954 | 4,454 | 4,131 | 4,596 | 5,164 | 5,664 | 5,193 | 6,905 | 9,005 |
| 2003 | 3,511 | 7,607 | 4,257 | 3,910 | 4,361 | 4,913 | 5,543 | 5,064 | 6,750 | 8,568 |
| 2004 | 3,362 | 7,290 | 4,114 | 3,715 | 4,326 | 4,461 | 5,160 | 4,964 | 6,790 | 8,323 |
| 2005 | 3,208 | 6,986 | 3,827 | 3,656 | 3,999 | 4,280 | 5,098 | 4,860 | 6,560 | 8,019 |
| Total Difference from 1996 to 2005 | 1,716 | **3,359** | 1,861 | 1,136 | 1,617 | 2,091 | 1,704 | 1,701 | 1,665 | **3,483** |

### 5.3 Average Durations

As mentioned earlier, to measure changes in utilization we examined the time between dental check-ups. The results demonstrate that the average length of time between visits increased through the late 90's, and more modestly until 2004. They underwent a slight decline from 2004 to 2005. These trends can be seen in Table 5.3, which provides the average durations broken down by year. Additionally, the length of time between dental visits varies by socioeconomic grouping. The average duration by SES grouping is presented in Table 5.4. The results show that the lower socioeconomic

deciles experienced the greatest increases in durations. The higher socioeconomic deciles experienced an increase in durations as well. However, the increase for SES80 and SES90 were considerably smaller than those of the lower socioeconomic deciles. This shows that as the fee differential grew larger, individuals in the lowest socioeconomic deciles were waiting the longest between maintenance visits. As shown in Table 5.4, the durations between maintenance visits increased to 96.16 days for SES00 in comparison to SES90, which increased by 58.49 days. This indicates that the lowest socioeconomic group was waiting 2 x longer for maintenance check-ups in comparison to the highest socioeconomic group.

**Table 5.3**

**Average Duration by Year**

| Year | Duration in days |
|---|---|
| 1996 | 196.61 |
| 1997 | 233.33 |
| 1998 | 257.52 |
| 1999 | 272.19 |
| 2000 | 276.68 |
| 2001 | 279.11 |
| 2002 | 277.18 |
| 2003 | 280.35 |
| 2004 | 282.81 |
| 2005 | 273.50 |
| Total Difference from 1996 to 2005 | 76.89 |

**Table 5.4**

**Average Duration by SES and Year**

| | SES00 | SES10 | SES20 | SES30 | SES40 | SES50 | SES60 | SES70 | SES80 | SES90 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1996 | 195.36 | 195.09 | 193.78 | 193.81 | 193.51 | 196.19 | 197.67 | 198.32 | 198.11 | 199.72 |
| 1997 | 243.39 | 239.75 | 224.04 | 230.07 | 222.95 | 227.14 | 234.56 | 241.45 | 233.18 | 237.35 |
| 1998 | 275.91 | 270.04 | 246.14 | 253.32 | 247.89 | 249.70 | 263.81 | 267.87 | 254.88 | 255.62 |
| 1999 | 300.48 | 288.5 | 267.14 | 273,47 | 264.17 | 267.92 | 273.25 | 289.75 | 262.63 | 262.94 |
| 2000 | 299.41 | 291.96 | 269.39 | 281.03 | 271.03 | 265.86 | 275.77 | 290.11 | 272.89 | 269.87 |
| 2001 | 306.04 | 292.47 | 278.04 | 281.18 | 273.54 | 276.69 | 272.99 | 292.42 | 274.40 | 271.12 |
| 2002 | 303.11 | 292.84 | 279.91 | 280.49 | 262.07 | 272.63 | 278.80 | 286.61 | 274.33 | 267.32 |
| 2003 | 308.17 | 302.54 | 279.63 | 272.31 | 275.01 | 279.53 | 281.18 | 293.39 | 271.96 | 262.68 |
| 2004 | 302.10 | 294.46 | 278.93 | 280.93 | 276.12 | 282.27 | 291.18 | 295.81 | 278.21 | 270.79 |
| 2005 | 291.55 | 290.11 | 271.73 | 272.84 | 263.12 | 281.91 | 282.43 | 283.49 | 263.92 | 258.21 |
| Total Difference Between 1996 to 2005 | **96.19** | 95.02 | 77.95 | 79.03 | 69.61 | 85.72 | 84.76 | 85.17 | 65.81 | **58.49** |

## 5.4 Duration Analysis

While the descriptive analysis is useful at showing the broad trends in dental usage, it does not establish the underlying relationship between the primary variables. To assess the relationship between variables a duration regression was used. The regression estimated the impact of fee differential, persons per dentist, gender, the fee differential linked to socioeconomic status, socioeconomic status, Census Divisions, and the year on the durations between dental visits. The relationship between durations and each variable

will be explained below in more detail.

The results of the frailty duration estimations are presented in Table 5.5. To interpret these results, one should keep in mind that a hazard ratio less than 1 indicates the presence of or more of that independent variable is associated with longer durations. A hazard ratio greater than 1 indicates the presence of or more of that independent variable is associated with shorter durations, all other things being equal. Statistical significance is established based on the p-value. The higher the p-value, the less likely it is that the observed relation between variables is true. Conventionally, behavioral studies set the cut-off p-value for statistical significance at 0.05, and this is the criterion used herein to determine statistical significance. A p-value of 0.05 indicates there is a 5% probability that the observed relationship between variables is not a true relationship (i.e. a Type I error). However, 95% of the time the same relationship between variables can be replicated (52). For example, the variable fee_diff (fee difference) is significant as the p-value is 0.000, meaning that there is a negligible chance that the observed relationship is due to sampling error. Clinical significance is assessed qualitatively. In using large adminstrative datasets there is a likelihood that many variables will be statistically significant, although for practical purposes their effect is negligible. There are no established benchmarks for what establishes clinical significance in policy orientated research.

**Table 5.5**

**Duration Regression Results**

| Variable | Hazard Ratio | p-value |
|---|---|---|
| fee_diff | 0.942 | 0.000 |
| persons per dentist | 1.001 | 0.092 |
| caries in previous year (1=yes) | 1.358 | 0.000 |
| emergency dental visits in previous year (1=yes) | 1.024 | 0.001 |
| age | 0.948 | 0.000 |
| sex (female = 1; male = 0) | 1.041 | 0.000 |
| ses00 | 0.887 | 0.000 |
| ses10 | 0.849 | 0.000 |
| ses20 | 1.008 | 0.766 |
| ses30 | 1.003 | 0.919 |
| ses40 | 0.953 | 0.058 |
| ses60 | 1.039 | 0.117 |
| ses70 | 1.021 | 0.404 |
| ses80 | 1.054 | 0.028 |
| ses90 | 1.079 | 0.001 |
| fd_ses00 | 0.991 | 0.000 |
| fd_ses10 | 1.007 | 0.000 |
| fd_ses20 | 1.000 | 0.815 |
| fd_ses30 | 1.003 | 0.076 |
| fd_ses40 | 1.004 | 0.009 |
| fd_ses60 | 1.004 | 0.013 |
| fd_ses70 | 1.002 | 0.349 |
| fd_ses80 | 1.012 | 0.000 |
| fd_ses90 | 1.017 | 0.000 |
| yr97 | 1.017 | 0.044 |
| yr98 | 0.776 | 0.000 |
| yr99 | 0.772 | 0.000 |
| yr01 | 0.843 | 0.000 |
| yr02 | 0.950 | 0.000 |
| yr03 | 1.049 | 0.000 |
| yr04 | 1.122 | 0.000 |
| yr05 | 0.883 | 0.000 |
| cd2 | 1.436 | 0.000 |
| cd3 | 0.971 | 0.375 |
| cd4 | 1.083 | 0.000 |
| cd5 | 0.778 | 0.000 |
| cd6 | 0.872 | 0.000 |
| cd7 | 1.023 | 0.269 |
| cd8 | 0.806 | 0.000 |
| cd9 | 0.530 | 0.000 |
| cd10 | 0.434 | 0.000 |

### 5.4.1 Fee Difference

The differential amount between what the Dental Association recommended and the amount paid by MCP is defined as the fee difference. For the variable fee_diff the hazard ratio is .942 suggesting that every dollar increase in the fee difference increases duration between dental visits by 5.8%. The relationship between the fee difference and durations indicates that as the fee difference is increasing, individuals are waiting for longer periods of time between dental check-ups. Additionally, the relationship is significant as the p-value is 0.000. This is clearly a clinically significant result.

### 5.4.2 Dentist to Population Ratio

The variable persons per dentists has a hazard ratio of 1.001 which implies that increasing the number of dentists decreases the durations between check-up visits. However, persons per dentists in the regression is not statistically significant as the p-value 0.092 which is greater than 0.05. This implies that service availability does not significantly impact duration times between dental visits.

### 5.4.3 Caries in Previous Year

The variable caries in the previous year has a hazard ratio of 1.358 which suggests that if a child had caries in the previous year it decreased durations between dental check-ups by 35.8%. The relationship between caries in the previous year and durations indicates that the presence of dental caries correlates to shorter periods of time between dental check-ups. Thus, if a child had caries at their last dental visits they have shorter

durations for their check-ups in comparison to children that did not have a carie at their last check-up. The relationship is significant as the p-value is 0.000. This is clearly a clinically significant effect.

### 5.4.4 Emergency Visits in Previous Year

The variable emergency visits in previous year has a hazard ratio of 1.024 which suggests that if a child had a emergency dental visit the previous year, it decreased the duration between dental visits by 2.4%. The relationship between emergency visits in previous year and durations indicates that an emergency visit correlates to slightly shorter periods of time between dental check-ups. If a child had an emergency visit, they have a shorter duration for their check-up visit in comparison to children who did not have an emergency visit. The relationship is significant as the p-value is 0.001. This would appear to be a borderline clinically significant effect.

### 5.4.5 Age

The variable age has a hazard ratio of 0.948 indicating that there are longer durations between dental check-ups for older children. The relationship is significant as the p-value is 0.000. What this might suggest is that parents send their younger children for more dental visits , but if they do not reveal any serious adverse dental outcomes they start to scale back their visits to the dentist particularly as these become more costly. This is a statistically significant effect.

### 5.4.6 Sex

The variable sex is coded so that female=1 and male=0. The hazard ratio is 1.041, which indicates males have longer durations between dental visits. The relationship between the variable sex and durations is significant as the p-value is 0.000. This implies the sex of an individual correlates to the length of time between dental check ups; females have shorter durations between check-ups in comparison to males. This is a clinically significant effect.

### 5.4.7 Socioeconomic Status

SES00 represents the least affluent individuals in the population while SES90 represents the most affluent individuals. SES is a continuous variable, and as such it needed to be broken down into categories to assess non-linearity. Thus, the results are compared to the reference category SES50. SES50 was chosen as the reference category since it falls in the middle of the distribution and as such allows for an easier interpretation of the impact of high or low SES on the durations between maintenance visits. This simply draws a picture of how these two groups differ to the middle reference category.

SES00, SES10, SES40 all have hazard ratios less than 1 indicating that individuals within these socioeconomic groups are increasing the length of the time between dental check-ups in comparison to the reference category. SES00 and SES10 are statistically significant as their p-value are $<0.05$, however SES40 is not statistically significant as its p-value is $> 0.05$. The remainders of the SES groups (SES20, 30, 60, 70, 80, 90) all have hazard ratios greater than 1 indicating that individuals within these

socioeconomic groups are decreasing their length of time between dental check-ups in comparison to the reference category. SES80 and SES90 are the only groups that are statistically significant as the p-values are $< 0.05$. At the low and high end of the SES distribution it appears that SES has a clinically significant impact on dental health utlization.

### 5.4.8 Fee Difference and Socioeconomic Status

The relationship between the fee differential linked to SES and durations is significant for most categories in comparison to the reference category (FD_SES50). This reference category was chosen for the same reasons as the reference category SES50 in the preceding section. FD_SES00 has a hazard ratio less than 1 indicating that as the fee difference is increasing, individuals in this socioeconomic group are waiting longer periods of time between dental check-ups as compared to the reference category. FD_SES10, 20, 30, 80 and 90 all have hazard ratios greater than 1 indicating individuals in these socioeconomic groups experience shorter durations between check-ups in comparison to the reference category. FD_SES00, 10, 40, 60, 80 and 90 are all statistically significant as their p-values are all $< 0.05$. FD_SES20, 30, 70 are not significantly significant as their p-values are $> 0.05$.

The evidence for SES suggests that durations tended to be longer for lower socioeconomic deciles. There does appear to be a weak pattern of the fee differential having the greatest impact on the least affluent families and having the least impact on the most affluent families. However, the overall pattern suggests a limited clinical effect.

### 5.4.9 Year

The relationship between the year and durations is explored where the year 2000 is used as the reference category. This means the coefficients are to be evaluated as compared to the reference category. The results demonstrate that all years are significant as they all have p-values of less than 0.05, however, the hazard ratio is only less than 1 from 1998 to 2002 and again in 2005. This means the length of time between dental visits was increasing during these time periods in comparison to the reference category. The hazard ratios were greater than 1 from 2003 to 2004, indicating that in these years the length of time between dental visits is shorter in comparison to the reference category.

### 5.4.10 Census Divisions

An individual's post code was linked to 1 of 10 Census Divisions. After examination, CD1 was deemed to be the most suitable to use as a reference category as it has the largest population thus it may be more stable in comparison to the other CD with smaller populations. However, the CD chosen is arbitrary as it simply serves as a reference category and is used to paint a clearer picture when interpreting the results. Since CD1 was used as the reference category it was omitted from the regression. Where an individual resided had a hazard ratio greater than 1 indicating that in some cases the length of time between dental check-ups decreased depending on where a person lived in comparison to the reference category. That is CD 2, 4, and 7 experienced shorter durations between dental check ups over the 10-year observation period. Results were significant for CD 2 and 4 (p-values $<0.05$). For CD 5, 6, 8, 9, and 10 the results

showed hazard functions of less than 1 and is significant (p-value <0.05) indicating the length of time between dental check ups was longer for persons living in these areas in comparison to the reference category. This variable captures if there are geographic differences in dental care utlization. These effects are large and are clinically significant. Table 5.6 show changes in durations by CD from 1996 to 2005.

Goodness of fit calculations for the variable persons per dentists was completed using McFadden's formula (90). The formula divides the number of people per CD by the number of dentists per CD, this calculation was completed annually and the figure used corresponds to the year in which the service took place.

**Table 5.6**

**Durations by CD, 1996-2005**

| CD | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 181.26 | 224.18 | 245.77 | 256.53 | 261.27 | 265.91 | 280.13 | 269.70 | 278.35 | 274.87 |
| 02 | 182.13 | 207.50 | 233.79 | 236.38 | 237.41 | 238.26 | 266.89 | 255.75 | 273.48 | 284.55 |
| 03 | 188.51 | 245.43 | 280.56 | 300.62 | 304.29 | 299.17 | 239.21 | 322.98 | 298.27 | 337.43 |
| 04 | 159.43 | 204.86 | 235.88 | 285.93 | 283.92 | 277.69 | 318.21 | 276.23 | 273.28 | 273.51 |
| 05 | 163.63 | 221.59 | 252.18 | 273.30 | 274.48 | 274.81 | 269.22 | 292.52 | 292.65 | 301.98 |
| 06 | 182.32 | 236.92 | 259.45 | 278.77 | 287.90 | 287.14 | 282.67 | 298.27 | 288.49 | 274.92 |
| 07 | 179.56 | 216.52 | 232.77 | 251.77 | 256.86 | 284.36 | 276.91 | 281.49 | 285.16 | 268.09 |
| 08 | 182.09 | 251.86 | 272.99 | 306.53 | 315.02 | 311.23 | 310.18 | 308.03 | 322.45 | 302.84 |
| 09 | 139.33 | 236.41 | 293.03 | 339.97 | 322.64 | 319.79 | 337.22 | 351.70 | 343.50 | 360.91 |
| 10 | 124.12 | 215.68 | 265.53 | 301.67 | 318.89 | 352.46 | 328.98 | 355.60 | 379.80 | 389.70 |

### 5.5 Impact of Increased Duration on Oral Health Status

The results in Table 5.3 clearly show that the durations between dental visits are increasing, for example in 1996 dental check-ups were occurring every 196.16 days and

in 2005 dental check-ups were occurring every 273.50 days. There was an increase in durations between dental visits by 77.34 days from 1996 to 2005. The next question to be addressed is whether this decrease in utilization has adverse effects on dental health. The number of dental caries and emergency visits are measures of oral health. The first step is to examine whether the incidences of caries increased between 1996 and 2005. The second step is to examine whether particular SES groups are more at risk of dental caries and emergency visits and whether these risks grew as families were required to pay a greater share of maintenance costs.

### 5.5.1 Dental Caries

To assess the effects of longer durations on a person's oral health care status, we examine the number of maintenance visit durations that ended with dental caries. Thus, the point of origin for a spell to begin is the first maintenance visit observed. Children whose spell began with a maintenance visit and ended in caries were counted. Table 5.7 shows the frequency of dental caries by year, along with the percentages of check-ups ending in dental caries. It was hypothesized that as the durations between maintenance visits increase the number of dental caries may also increase. However, the results reveal the overall trend of dental caries did not increase with longer durations between check-ups. The percentage of dental caries ranged from 26.00 % in 1996 to 24.95% in 2005. 1998 was the only year that experienced an increase in dental caries. The percetages represent the proportion of duration between maintenance visits that were interupted by a dental carie.

**Table 5.7**

**Dental Caries by Year – Frequency & Percentages**

| Year | Frequency | Percentages |
|---|---|---|
| 1996 | 15,399 | 26.00 |
| 1997 | 14,347 | 25.39 |
| 1998 | 14,284 | 26.29 |
| 1999 | 13,704 | 25.90 |
| 2000 | 13,437 | 25.93 |
| 2001 | 12,667 | 25.27 |
| 2002 | 11,601 | 24.37 |
| 2003 | 11,116 | 24.51 |
| 2004 | 10,406 | 24.15 |
| 2005 | 9,345 | 24.95 |

### 5.5.2 Dental Caries and Socioeconomic Quintiles

Another objective of the study is to determine the impact that increased durations have on dental caries across socioeconomic quintiles. Here, quintiles are used instead of deciles because the number of occurrences of caries is smaller making a larger grouping such as quintiles more appropriate than deciles. Quintile 1 represents individuals with the lowest SES status and quintile 5 represents individuals with the highest SES status. There is a clear pattern of children from the lower SES quintiles having more caries as seen in Table 5.8; however, they do not appear to become more at risk as the duration between visits increases. The overall patterns suggest the incidence of caries is declining over the observation period. Another key question here is whether the differences observed between the quintiles in 1996 get larger or smaller or if they stay roughly the

same by 2005. The results show that differences between the quintiles stay roughly the same from 1996 to 2005. This indicates that, while individuals from lower SES groups are more likely to experience caries, longer durations between maintenance visits does not appear to have increased this risk.

**Table 5.8**

**Dental Caries by Year and Socioeconomic Quintiles**

| Year/Quintile | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1996 | 3300 | 2969 | 2881 | 2459 | 2024 |
| 1997 | 3193 | 2783 | 2687 | 2363 | 1854 |
| 1998 | 3070 | 2870 | 2870 | 2311 | 1922 |
| 1999 | 2964 | 2821 | 2821 | 2292 | 1889 |
| 2000 | 2939 | 2773 | 2773 | 2185 | 1826 |
| 2001 | 2729 | 2728 | 2728 | 2130 | 1661 |
| 2002 | 2509 | 2564 | 2564 | 1945 | 1686 |
| 2003 | 2385 | 2361 | 2361 | 2009 | 1528 |
| 2004 | 2312 | 2285 | 2285 | 1904 | 1488 |
| 2005 | 2069 | 1991 | 1991 | 1725 | 1420 |

### 5.5.4 Emergency Visits

To assess the effects of longer durations on a person's oral health care status the number of spells that ended in an emergency visit were counted by year. Thus, the point of origin for a spell to begin is the first check-up observed. The spells ending in emergency visits were counted and compared with children who only had spells ending in a subsequent maintenance visit. Table 5.9 shows the frequency of emergency visits by year and the percentages of check-ups ending in emergency visits. The results reveal an overall decrease in the number of emergency visits as the durations between check-ups lengthened. The percentage of emergency visits ranged from 13.6% in 1996 to 12.35% in 2005. The number of emergency visits steadily declined between 1996 and 2005. Similar to caries, the evidence here does not suggest that longer durations place individuals at a higher risk of requiring an emergency dental visit.

**Table 5.9**

**Emergency Visits by Year – Frequency & Percentages**

| Year | Frequency | Percentages |
|---|---|---|
| 1996 | 7163 | 13.36 |
| 1997 | 6756 | 13.08 |
| 1998 | 6725 | 13.01 |
| 1999 | 6737 | 13.54 |
| 2000 | 6599 | 13.56 |
| 2001 | 6667 | 12.98 |
| 2002 | 6333 | 12. 92 |
| 2003 | 5790 | 12.63 |
| 2004 | 5508 | 12.02 |
| 2005 | 4788 | 12.35 |

### 5.5.5 Emergency Visits and Socioeconomic Quintiles

This research sought to determine the impact that increased durations have on emergency visits across socioeconomic quintiles. Identical to the examination of dental caries the research examines how many maintenance visit spells end in emergency visits across quintiles with the view to establish if lower SES groups were more adversely affected by having longer durations between maintenance visits. The results show a reduction in the number of emergency visits by year across all SES quintiles indicating that increasing durations between check-ups are not correlated with more emergency visits. It should be noted that the lowest socioeconomic group had the greatest frequencies of emergency visits throughout the observation period. This trend can be viewed in Table 5.10.

**Table 5.10**

**Emergency Visits by Year and Socioeconomic Quintiles**

| Year/Quintile | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 1996 | 1745 | 1521 | 1347 | 1348 | 1081 |
| 1997 | 1781 | 1586 | 1391 | 1321 | 1055 |
| 1998 | 1662 | 1554 | 1356 | 1254 | 1061 |
| 1999 | 1590 | 1510 | 1415 | 1269 | 1079 |
| 2000 | 1598 | 1552 | 1353 | 1290 | 1076 |
| 2001 | 1659 | 1537 | 1302 | 1283 | 1006 |
| 2002 | 1543 | 1591 | 1376 | 1276 | 1043 |
| 2003 | 1544 | 1389 | 1239 | 1246 | 950 |
| 2004 | 1422 | 1394 | 1165 | 1102 | 862 |
| 2005 | 1303 | 1286 | 1063 | 1007 | 879 |

**5.6 Conclusion**

The descriptive analysis shows that over the 10- year observation period there was a decline in utilization of the DHP for maintenance procedures. This decline in utilization can be seen across all socioeconomic groups. The analysis also demonstrates that the length of time between check-ups increased by 76.89 days between 1996 and 2005 as seen in Table 5.3. Additionally, the length of time between dental visits varied by socioeconomic grouping; the lower socioeconomic groups experienced the greatest increase in durations. This trend can be seen in Table 5.4.

The duration regression reveals a significant relationship between durations and several independent variables. Most importantly for this research, the fee difference was significant with a hazard ratio less than 1, which implies that the length of time between dental check-ups was directly affected by the increasing fee differential and the level of availability of dental providers. Furthermore, there appears to be a pattern that suggests that utlization is lower among the lowest SES group and that the poorest were most adversely affected by the subsidy freeze. All CDs were statistically significant except for 3 and 7, this demonstrates that the length of time between dental check-ups varied depending on location (see Table 5.6). It may be flat in some CDs, while there may be practicioners the distance needed to travel to see them in considerable and as such may reduce utlization. The meaning of these results indicates that service availability may impact durations between dental check-ups.

The socioeconomic indicators suggest that the lowest socioeconomic deciles tended to have the longest durations between visits (see Table 5.4). However, interacting the fee difference to the socioeconomic deciles did not reveal any distinct pattern. This

suggests that while freezing the dental subsidy did reduce utilization, lower socioeconomic families were not particularly sensitive to the changes year over year.

The duration regression reveals a significant relationship between durations and sex. This indicates that sex influences the length of time between dental check ups; females have shorter duration times in comparison to males.

Finally, a likelihood ratio test examining the significance of the frailty term rejected the null of no frailty with $p < 0.000$, suggesting that unobserved heterogeneity is an important component in these data and that failure to account for it could potentially introduce significant bias into the estimates. Since the frality is significant, it suggests that incorportating it into the duration model is appropriate.

# Chapter 6: Discussion

## 6.1 Introduction

The main reason for this study was to examine the impact of freezing the dental subsidy on children under the age of 13. Utilization was measured by counting the number of check-ups, cleanings, and fluoride treatments. The results of the study confirm that utilization of the DHP for children under the age of 13 years declined from 1996 to 2005, with the absolute number of dental claims falling and the duration of time between visits increasing (see Table 5.3). Explanations for this decline include population decline and/or an increasing fee difference, making it more expensive for parents to take their children to the dentist. The results show an association between the fee difference and durations, as the fee difference widened the length of time between check-up visits increased. This trend occurred in a stepwise fashion across all socioeconomic groups. Individuals in the lowest socioeconomic group (SES00) saw the greatest increase in durations over the 10-year study period (increase of 96.16 days). This is compared to those in the highest socioeconomic group (SES90) that had increasing durations, but to a lesser extent; individuals in SES90 lengthened their time between visits by 58.49 days. Additionally, differences in durations between SES groups widened as the fee difference increased over the study period. For example, in 1996 those in the lowest socioeconomic group had an average duration of 195.36 days, while the highest socioeconomic group had an average duration of 199.72. By 2005 those in the lowest socioeconomic group had an average duration of 291.55, while the highest socioeconomic group had an average duration of 258.21.

At the beginning of the study period, there was a lack of evidence on the relationship between socioeconomic status and seeking dental health care services in Newfoundland and Labrador. This relationship emerged over the 10-year study period, this pattern is compatible with the hypothesis that the dental health plan as it existed in 1996 was better at meeting the needs of low income earners. Then the plan became progressively unable to meet those needs due to the frozen subsidy, which increased out of pocket cost to the consumer. These results are supported by research, which was completed in Canada (9) and in the United States (44), which showed an inverse relationship between seeking dental health care services and SES. Generally, the literature reviewed showed a relationship between SES and oral health care status; the result is a lower level of oral health care for financially disadvantaged families. However, it should be noted that there is no research specifically looking at the length of time between check-up visits as a function of SES and how changes in coverage under a dental plan effects utilization of dental services. For this reason, there may be differences in results if the study were replicated in another location because of the lack of an across-the-board dental plan for all children in other parts of Canada and the world. However, it is clear that as the cost of dental care increases for families, they respond by going to the dentist for maintenance procedures less frequently.

Research done in North America and Europe has made the generalized conclusion that oral health care is affected by a patient's socioeconomic status as mentioned above (31-35). However, this trend is not constant across countries. Even within countries, it changes by decade. Thus, while it is known that SES influences the demand for oral heath care, there is a wide variability in the significance of SES on good oral hygiene.

Possible reasons cited for such variability with regard to the effect of SES on utilization include differences in accessibility of dental care providers and the comprehensiveness of government funded dental health programs (28). In this study while utilization patterns do appear to be influenced by SES and outcomes are also associated with SES, it is not clear that a decrease in utlization by lower SES groups has contributed to the SES gap in oral health outcomes.

The second main objective of the study was to determine if longer durations between check-ups visits had a negative impact on an individual's oral health status, with a secondary objective of examining differences across socio-economic quintiles. Incidences of caries and emergency visits following a check up visit are the measures used to assess a decline in oral health status. The results demonstrate that each year the number of dental caries across all socio-economic groups declined (Table 5.8), even though there was a significant increase in the length of time between dental check ups (Table 5.3). The number of check ups ending in emergency visits decreased slightly in the entire study population, however, the incidence of emergency visits is still significantly higher in the lowest socio-economic groups and this group experienced the smallest decline in emergency visits (Table 5.10). While the results demonstrated an association between the length of time between dental maintenance and SES, it appears that increased durations did not negatively affect children's oral health status, which is shown by a decrease in the number of emergency visits and dental caries.

The message is that dental care is price sensitive and that further reductions in the DHP will likely further reduce program uptake and that this is most likely to be concentrated among individuals from the poorest families. The evidence does not,

however, strongly suggest that the decline in maintenance visits over the past decade has coincided with an increase in caries or emergency visits. However, it may be that some individuals are of high risk and should perhaps be given a more generous subsidy. A one size fits all program may not effectively deal with individuals who are of high need and particularly if they come from a poorer background. A study (91) demontrated that a caries-control regime based on individual need resulted in a 44.3% decrease in DMFT scores in comparison to a traditional standard care program. Furthermore, while the initial cost of an individualized caries-control regime was more expensive initially, after two years the program became less expensive than standard care because the cost of treatment for DMFT was averted (91).

There has been little research done on emergency dental visits, thus these results cannot be directly compared to other research. The data shows that emergency visits decline across deciles over the period and that the proportion of durations between maintenance visits interrupted by an emergency visit declines over the observation period. However, it is possible that as the length of the duration increased there were more emergency visits but they seek emergency medical services rather than emergency dental services. Previous research by Wang (15) demonstrates that when coverage for dental care was lacking, subjects sought out medical treatment. In fact 68% of the study population in the Wang study (15) had a prescription to deal with their dental problem prescribed by a physician rather than a dentist. Children's medical records were requested from the Janeway Children's Hospital in St. John's, Newfoundland and Labrador in order to determine if there was an increase in the number of children receiving emergency care at the hospital for oral health related problems. However, this

detailed information was not recorded and maintained by the hospital. Thus, even though there was a decrease in the number of emergency visits to a dental care provider as durations increased, we may not be seeing the entire story as we have no way of establishing if there was a increase in the number of children in the medical system for dental related emergencies.

Research (10,12-15, 24, 25, 27, 31, 37, 39, 42, 43, 57, 59, 70, 71, 73, 74) has been done in other jurisdictions on recall times for children's dental check ups. The literature offers no clear consensus on the most appropriate recall interval, and there is considerable variability within and between countries. For instance, in Finland, the state dental plan provides check-ups for children annually, but the policy in the United Kingdom is to provide biannual check-ups (10, 14). In Canada, recall intervals not only differ from other industrialized nations, but they differ between its provinces and territories (Table 1). The DHP allows children to have biannual check-ups while other provinces have policies that range from children receiving subsidized annual check-ups to none at all.

Based on the study's overall results, the impact of longer durations on oral health outcomes is not large. However, there are key differences across socioeconomic groups that suggest freezing the DHP subsidy has had the greatest impact on Newfoundland and Labrador's poorest citizens. Therefore, it is suggested the DHP policy needs to be reviewed. Currently, the plan is providing universal coverage for all children under the age of 13 residing in the province of Newfoundland and Labrador. However, it has been demonstrated that most children are not affected when the length of time between dental visits increases. Rather than offering subsided biannual check-ups for all, it may be more appropriate and less costly to provide these services to select children. The criteria for

eligibility for a biannual check-up would be children labeled as high risk for dental caries. Low risk children could be reduced to an annual maintenance visit.

Based on the literature, (23-25) high risk is defined based on various measures. However, in most studies it is defined by the number of decayed, missing and filled teeth (DMFT). Children with high DMFT scores are identified as high risk and benefit from regular recall check-ups from as frequently as every three months for the most severe cases (23). A potential way to execute this plan is to have dentists initially screen a child as high risk for dental caries, and if they deem the child as high risk they set aside the child's dental chart. To ensure the diagnosis is accurate and not based on the sole discretion of the dental provider, an independent third party may be hired by the government to review these "high risk" charts to determine if in fact the child qualifies for more extensive dental health coverage.

The government may wish to have two dental health policies; one for low risk children providing subsided annual check-ups, and one for high risk children with varying subsided recall check-ups based on severity of symptoms. It would be more beneficial if the DHP provided a more universal form of reduced coverage and allocated the savings to the dental budget to children who are at a higher risk for dental caries and dental emergencies. Additionally, the new plan would provide appropriate individualized dental health care services for all children residing in Newfoundland and Labrador.

Quality of life factors are often overlooked, however, research (16, 17, 21, 24, 76) demonstrates the value of using quality of life meaures to direct policymaking. Quality of life measures can be compared prior to an oral procedure and after and can demonstrate the extent an oral health intervention has had on a child's quality of life. The

preliminary results thus far show that dental caries have a large affect on the emotional and social well being of children ranging from 11 to 14 (17). The economic impact of using quality of life factors is not well captured by the current literature. Casamassimo et al. (89) state that traditional oral health outcomes such as the decayed-missing-filled teeth (DMFT) index do not capture the effects early childhood caries have on children, families, society and the health care system. They suggest that policy making needs to extend beyond the dental office to capture the toll caries have on children, if caries are untreated it they lead to chronic pain and can affect development, school performance and behavior. Quality of life measures may solidify the importance of offering subsizidized dental care to children in Newfoundland and Labrador and may be used to direct changes to the DHP in the future.

It could be argued that the reason there is decline in utilization is because there are simply fewer children residing in Newfoundland and Labrador. It is recognized that population migration is a reality in Newfoundland and Labrador. However, it is felt that it will not have a large impact on our analysis as families with young children will be less mobile in comparison to young adults with fewer responsibilities. As a means to address the impact of population changes in Newfoundland and Labrador, dental records were matched to MCP records to identify individuals who had cancelled their health care cards, which are attached to their PIN numbers. We stopped observing a person on the date the PIN was terminated.

It should be noted that when doing the descriptive analysis the number of dental caries and emergency visits were shown as a proportion of the number of children receiving check ups. For the duration analysis, the length of time between visits was

individual specific. These points are important as the study is not simply counting the number of dental visits by year and stating that there is a decline in utilization. Rather it is assessing utilization by examining the population who have sought services in the past.

Another explanation for a decline in the utilization of the DHP is the availability of dental service providers. Research has shown that individuals residing in rural areas have poorer level of oral and medical health. The reason given for this is the lack of accessibility of these services (11, 13). Additionally, individuals residing in rural areas tend to be less affluent. To address this problem a measure was created providing the number of persons per dentist; linking a dentist and study subjects to a CD for each year of the study. Since population figures from Statistics Canada were only available for the 1996, 2001 and 2006 Census, population projections were estimated for other years. There was a higher patient per dentist ratio for CDs that covered a large geographical area and were mainly rural, but the ratio displayed considerable variation in some of these CDs over time due to the low numbers of dentists practicing there. There was a lower patient per dentist ratio for CDs that were mainly urban, this implies a trend for dentists to practice in urban rather than rural settings, which may impact durations as services may be lacking in rural areas.

The literature suggests a way to reach children with limited accessibility is to utlize dental auxillaries. Dental auxillaries have proven to be of value in rural locations by decreasing DMFT scores and plaque and gingivties index (81-84). The province may wish to do additional research to assess the impact service avaiability has on utilization of the DHP; if the impact is large a solution may be to train and place dental auxillries in areas where dental services are lacking. Additionally, caries prevention program run by

dental auxillaries (89, 91-92) have demonstrated they are cost effective and improve dental outcomes which is demonstrated by decreasing DMFT scores.

# Chapter 7: Conclusion

## 7.0 Introduction

Four main conclusions can be made from this research. Firstly, the study established there was decline in the number of children utilizing the DHP (Table 5.1). Secondly, there were longer durations between dental check-ups as the fee difference increased over time. Table 5.3 shows the length of time between dental check-ups increased over the 10-year period by 76.89 days. Thirdly, longer durations between dental check-ups had little impact on dental caries as caries decreased over time and across socioeconomic quintiles (Table 5.7, 5.8). Finally, longer durations between dental check-ups coincided with a slight decrease in emergency visits over time and across all socioeconomic quintiles (Table 5.9, 5.10). However, the number of caries and emergency visits were higher for the lowest socioeconomic quintile.

## 7.1 Study Limitations

Administrative data were used in the study; this type of data offers a relatively inexpensive way to assess trends in utilization in almost all individuals within a chosen population of interest. Another benefit of using administrative data is they contain many dental health related variables. However, by recording so much general information the amount of detailed individual specific information may be sacrificed. Additionally, the accuracy of administrative databases is an issue. The MCP database was created in 1969 and much of the information in the system is outdated, the province recognizes this flaw and is in the process of re-registering residents of Newfoundland and Labrador. Thus,

some of the information used such as postal codes may be inaccurate and affect the results involving socioeconomic status, but more accurate postal code information would likely show the same findings.

Detailed information about the type of dental procedures received and the cost of the procedure is provided in the database, however dental utilization cannot be ascertained for the entire population of children residing in Newfoundland and Labrador. The data provides a good measure of dental utilization for children using the DHP, but the analysis does not represent the province's children who do not use the DHP. Additionally, the database only contains records when a child visits the dentist. However, we do not know if children are seeking additional medical care as a subsitute as the fee difference increases rather than dental care.

The DHP records are linked to the MCP records as an individual has the same unique patient identifier under both plans. The study looked at the PIN in the medical and dental records to show that a person was still living in Newfoundland and Labrador even though they did not receive dental services. Individuals who had moved from Newfoundland and Labrador and cancelled their PIN were dropped from the study. However, there may be several children included in the analysis that are no longer residents of this province. If an individual does not cancel their PIN there is no way of knowing if they have left the province.

Analysis of the MCP database shows the length of time between dental visits for children has increased from 1996 to 2005. It is inferred the reason for the longer duration is due to a decline in the dental subsidy, which has lead to an increase in the fee difference. The database does not capture other possible explanations, such as a change

in a person's dental health views or additional preventive programs in the community. There may be many factors causing an increase in durations that are unknown.

The results show that longer durations between maintenance visits did not lead to an increase in dental caries. However, dental caries may have declined due to personal oral health care practices. For example, a subject may have decreased dental caries because they started to use fluoride toothpaste or they reduced the amount of acidic food and liquids they consume. Both have been documented to lead to a decrease in caries (8, 9). It is not known what effects that these other factors have on the study's findings as there is no way to capture these using this administrative dataset.

### 7.2 Value of the Research

After an extensive literature review it is clear that oral health research is moving towards evidence based dentistry, however, there are no clear guidelines on optimal dental health care utlization practices. This is especially true for recall intervals. An appropriate recall interval is a balance between reducing costs, but not adversley impacting oral health outcomes. This research study demonstrated that the current six month recall interval for the province of Newfoundland and Labrador may not be the most appropriate way to spend the DHP budget. As the durations between dental check-ups increased there was no increase in dental caries or emergency visits, which implies that not all children need to visit the dentist every six months. Perhaps, some of the cost savings could be re-directed into new dental health programs for the least affluent individuals in the province.

**7.3 Implications**

This study has demonstrated an emerging difference across socioeconomic deciles in utilization of the DHP by children under the age of 13 in Newfoundland and Labrador. The socioeconomic difference appears in the duration model where the lowest socioeconomic groups wait the longest between dental check-ups and experience the greatest increase in the proportion of check-ups ending in emergency visits. However, we do not know with any certainty how much of this phenomenon is related to social differences such as the type of dental treatment received. For example, a low-income patient has an oral health problem not covered under the DHP, the dentist is aware of a person's financial situation and decides against treatment as it would be difficult to recoup the cost from the patient or that the patient decides to forego treatment due to the prohibitive cost. Further research on whether lower socioeconomic groups are receiving equal treatment as higher socioeconomic groups is required to better understand how differences in socioeconomic status impact oral health outcomes.

The research demonstrates that as durations become longer the number of dental caries actually decreased. However, this is just an overall trend for the entire population. Children at a higher risk for dental caries may experience additional caries as durations increase; however, children at a low risk for dental caries who experience no adverse effects on their oral health, as duration's increase would counter balance this.

As a continuation of this research, it would be recommended that the province create a measure to capture the number of children in the MCP database with emergencies related to oral health problems. The study demonstrates that as it becomes

more expensive to visit the dentist (larger fee difference) and as durations increase there is a slight decrease in the number of emergency dental visits. It appears the province saved resources by freezing the dental subsidies under the DHP and it has no adverse effect on the oral health status of children at the population level. However, these results may not capture the true cost picture as children may be simply shifting from the DHP to the MCP.

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## Appendix 1: Dentists by community and Census Division

| 2006: Community Name | 2006: Postal Codes | 2005: Community Name | 2005: Postal Codes |
|---|---|---|---|
| Mt. Pearl | A1N5B5 | Corner Brook | A2H6R6 |
| Corner Brook | A2N6R6 | Mt. Pearl | A1N1X6 |
| Mt. Pearl | A1N5B5 | Deer Lake | A8A2B9 |
| Deer Lake | A8A2B9 | St. John's | A1E5Z6 |
| St. John's | A1E5Z6 | Harbour Grace | A0A2M0 |
| St. John's | A1B2X1 | St. John's | A1B2X1 |
| St. John's | A1A5T3 | St. John's | A1B1W3 |
| Mt. Pearl | A1N3K1 | Mt. Pearl | A1BN3K1 |
| Deer Lake | A8A1E2 | Deer Lake | A8A1E2 |
| Corner Brook | A2H4C7 | Corner Brook | A2H4C7 |
| St. John's | A1A2M7 | St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A2J7 | Grand Falls-Windsor | A2A2J5 |
| CBS | A1W3A6 | CBS | A1W3A6 |
| CBS | A1W5T2 | Grand Falls-Windsor | A2A1V8 |
| Goose Bay | A0P1C0 | St. John's | A1B3Y8 |
| Stephenville | A2N2Y9 | St. John's | A1E2E2 |
| Corner Brook | A2H2Y6 | St. John's | A1E2E2 |
| Placentia | A0B2Y0 | St. John's | A1A4A5 |
| St. John's | A1E4N1 | Goose Bay | A0P1C0 |
| Grand Falls-Windsor | A2A2J3 | Goose Bay | A0P1C0 |
| Stephenville Crossing | A0N2C0 | CBS | A1W3A6 |
| Carbonear | A1Y1A6 | St. John's | A1A2G8 |
| St. John's | A1A1W7 | Lewisport | A0G3A0 |
| St. Anthony | A0K4S0 | St. John's | A1B1R6 |
| St. Anthony | A0K4S0 | St. John's | A1C2H5 |
| St. John's | A1A4A5 | Clarenville | A5A2Y8 |
| Stephenville | A2N2P4 | Grand Falls-Windsor | A2A1V8 |
| St. John's | A1B5C3 | St. John's | A1V1W5 |
| Grand Falls-Windsor | A2A2C9 | St. John's | A1A1W7 |
| Corner Brook | A2H5G3 | Carbonear | A1Y1A4 |
| Paradise | A1L3W4 | Mt. Pearl | A1N3J6 |
| Corner Brook | A2H4B5 | St. John's | A1B1W3 |
| Gander | A1V1H6 | St. John's | A1A4A5 |
| Holyrood | A0A2R0 | St. John's | A1A2G8 |
| Paradise | A1L1N9 | Grand Falls-Windsor | A2A1V8 |
| Mt. Pearl | A1N3K1 | St. John's | A1A2M7 |
| Portugal Cove | A1M2B8 | St. John's | A1A2M7 |
| Bonavista | A0C1B0 | Grand Bank | A0E1W0 |
| Twillingate | A0G4M0 | St. John's | A1C2H5 |
| Bay Roberts | A0A1G0 | St. Anthony | A0K4S0 |
| Port Aux Basques | A0M1C0 | Grand Falls-Windsor | A2A2C9 |
| St. John's | A1E2Y2 | St. John's | A1B1W3 |
| St. John's | A1E2M7 | Harbour Grace | A0A2M0 |
| St. John's | A1E4N1 | CBS | A1W5T2 |

| | |
|---|---|
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| St. John's | A1B1W3 |
| Carbonear | A1Y1B7 |
| Corner Brook | A2H2Y6 |
| St. John's | A1B1W3 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H2R1 |
| CBC | A1X3H1 |
| St. John's | A1A1W7 |
| St. John's | A1A2G8 |
| Bay Roberts | A0A1G0 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Clarenville | A5A1R4 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Mt. Pearl | A1N1X6 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| St. Anthony | A0K4S0 |
| Gander | A1V2S3 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H2Y6 |
| Stephenville | A2M3B4 |
| CBS | A1W3A6 |
| St. John's | A1E4J8 |
| St. John's | A1E4N1 |
| St. John's | A1B3V6 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Goose Bay | A0P1C0 |
| Gander | A1V1W5 |
| Goose Bay | A1P1S0 |
| St. John's | A1A4A5 |
| Mt. Pearl | A1N5B5 |
| Roddickton | A0K4P0 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| Burin Bay Arms | A0E1G0 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1A1W7 |
| Bay Roberts | A0A1G0 |
| Grand Falls-Windsor | A2A1V8 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N3B4 |
| Corner Brook | A2H2Y6 |
| Placentia | A0B2Y0 |
| St. John's | A1E4N1 |
| Grand Falls-Windsor | A2A2J3 |
| Stephenville Crossing | A0N2C0 |
| Carbonear | A1Y1A6 |
| St. Anthony | A0K4S0 |
| St. Anthony | A0K4S0 |
| St. John's | A1A4A5 |
| Stephenville | A2N2M9 |
| St. John's | A1B1W3 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5G3 |
| Paradise | A1L3W4 |
| Corner Brook | A2H4B5 |
| Gander | A1V1H6 |
| Holyrood | A0A2R0 |
| Paradise | A1L1N9 |
| Portugal Cove | A1M2B8 |
| Goose Bay | A0P1E0 |
| Bonavista | A0C1B0 |
| Twillingate | A0G4M0 |
| CBS | A1X3H1 |
| Goulds | A1S1GB |
| Goose Bay | A0P1C0 |
| St. John's | A1B2X2 |
| St. John's | A1A5A1 |
| St. John's | A1B1W3 |
| St. John's | A1A1W8 |
| Glovertown | A0G2L0 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2Y6 |
| St. John's | A1E5Z6 |
| Grand Falls-Windsor | A2A2K3 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Forteau | A0K2P0 |
| St. John's | A1A1W7 |
| Labrador City | A2V1L1 |
| Gander | A1V2S3 |
| St. John's | A1C6C9 |
| Mt. Pearl | A1N1X6 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1B2X1 |

| | |
|---|---|
| St. John's | A1B1C1 |
| St. John's | A1E2E2 |
| St. John's | A1E2E2 |
| St. John's | A1A4A5 |
| Goose Bay | A0P1C0 |
| Gander | A1V1X1 |
| Goose Bay | A0P1C0 |
| CBS | A1W3A6 |
| St. John's | A1A2G8 |
| Lewisporte | A0G3A0 |
| St. John's | A1B1R6 |
| St. John's | A1C2H5 |
| Clarenville | A5A1Z1 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1V1W5 |
| St. John's | A1A1W7 |
| Carbonear | A1Y1A4 |
| Mt. Pearl | A1N3J6 |
| St. John's | A1A4A5 |
| St. John's | A1A2G8 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1A2M7 |
| St. John's | A1A2M7 |
| St. John's | A1A2M7 |
| St. John's | A1A2H5 |
| Grand Falls-Windsor | A2A2C9 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Steady Brook | A2H2N2 |
| Goulds | A1S1G8 |
| Goose Bay | A0P1C0 |
| St. John's | A1B2X2 |
| St. John's | A1A5A1 |
| St. John's | A1A5T3 |
| St. John's | A1A1W8 |
| Glovertown | A0G2L0 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2Y6 |
| St. John's | A1E5Z6 |
| Mt. Pearl | A1N1W1 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Labrador City | A2V1L1 |
| Gander | A1V2S3 |
| St. John's | A1C1A9 |
| Pasadena | A0L1K0 |
| St. John's | A1B2X1 |
| St. John's | A1E1P8 |
| Wabush | A0R1B0 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Goose Bay | A0P1E0 |
| Bay Robert's | A0A1G0 |
| Port Aux Basques | A0M1C0 |
| St. John's | A1E2Y2 |
| St. John's | A1A2M7 |
| St. John's | A1E4N1 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| St. John's | A1B1W3 |
| Carbonear | A1Y1B7 |
| Corner Brook | A2H2Y6 |
| St. John's | A1B1W3 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H6Z1 |
| CBC | A1X3H1 |
| St. John's | A1A1W7 |
| St. John's | A1A2G8 |
| Bay Robert's | A0A1G0 |
| St. John's | A1E1P8 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Clarenville | A5A1R4 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitebourne | A0B2K0 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H2Y6 |
| Stephenville | A2M3B4 |
| CBS | A1W3A6 |
| St. John's | A1E4J8 |
| St. John's | A1E4N1 |
| St. John's | A1B3V6 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A2R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Goose Bay | A0P1C0 |
| Gander | A1V1W5 |
| Goose Bay | A1P1S0 |
| St. John's | A1A4A5 |

| | |
|---|---|
| St. John's | A1E1P8 |
| Wabush | A0R1B0 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Goose Bay | A0P1E0 |
| Grand Falls-Windsor | A2A2C9 |
| Mt. Pearl | A1N5B5 |
| Roddickton | A0K4P0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| Burin Bay Arm | A0E1G0 |
| Grand Falls-Windsor | A2A1V8 |

| **2004: Community Name** | **2004: Postal Codes** | **2003: Community Name** | **2003: Postal Codes** |
|---|---|---|---|
| Corner Brook | A2H6R6 | Corner Brook | A2H6R6 |
| Corner Brook | A2H2Y6 | St. John's | A1B1W3 |
| Mt. Pearl | A1N1X6 | Mt. Pearl | A1N1X6 |
| Deer Lake | A8A2B9 | Deer Lake | A8A2B9 |
| St. John's | A1E5Z6 | St. John's | A1E5Z6 |
| Harbour Grace | A0A2M0 | Harbour Grace | A0A2M0 |
| St. John's | A1B4J9 | St. John's | A1B1W3 |
| St. John's | A1B1W3 | Mt. Pearl | A1N2C1 |
| Mt. Pearl | A1N2C1 | Deer Lake | A8A1E2 |
| Deer Lake | A8A1E2 | Corner Brook | A2H4C7 |
| Corner Brook | A2H4C7 | St. John's | A1A2M7 |
| St. John's | A1A2M7 | Manuels | A1V1M8 |
| Grand Falls-Windsor | A2A2J5 | Grand Falls-Windsor | A2A1V8 |
| CBS | A1W3A6 | St. John's | A1B3Y8 |
| Grand Falls-Windsor | A2A1V8 | St. John's | A1E2E2 |
| St. John's | A1B3Y8 | St. John's | A1E2E2 |
| St. John's | A1E2E2 | St. John's | A1A4A5 |
| St. John's | A1E2E2 | Mt. Pearl | A1N2C1 |
| St. John's | A1A4A5 | Goose Bay | A0P1C0 |
| Goose Bay | A0P1C0 | Goose Bay | A0P1C0 |
| Goose Bay | A0P1C0 | Manuels | A1W1M8 |
| CBS | A1W3A6 | St. John's | A1A2G8 |
| St. John's | A1A2G8 | Grand Falls-Windsor | A2A2S4 |
| Lewisport | A0G3A0 | St. John's | A1B1R6 |
| St. John's | A1B1R6 | St. John's | A1C2H5 |
| St. John's | A1C2H5 | Clarenville | A0E1J0 |
| Clarenville | A5A1Z1 | Bay Roberts | A0A1G0 |
| Grand Falls-Windsor | A2A1V8 | Gander | A1V1W5 |
| Bay Roberts | A0A1G0 | St. John's | A1A1W7 |
| St. John's | A1V1W5 | Carbonear | A1Y1A4 |
| St. John's | A1A1W7 | Mt. Pearl | A1N3J6 |
| Carbonear | A1Y1A4 | St. John's | A1A4A5 |
| Mt. Pearl | A1N3J6 | Burin Bay Arm | A0E1G0 |
| St. John's | A1B1W3 | St. John's | A1A2G8 |

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|---|---|
| St. John's | A1A4A5 |
| Burin Bay Arm | A0E1W0 |
| St. John's | A1A2G8 |
| St. John's | A1A2M7 |
| St. John's | A1A2M7 |
| Grand Bank | A0E1W0 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| Brookfield, B. Bay | A0G1J0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| CBS | A1W5T2 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2Y6 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Grand Falls-Windsor | A2A1V8 |
| Stephenville Crossing | A0N2C0 |
| Carbonear | A1Y1A6 |
| Mt. Pearl | A1N5B5 |
| St. Anthony | A0K4S0 |
| St. Anthony | A0K4S0 |
| St. John's | A1A4A5 |
| Stephenville | A2N2Y9 |
| Grand Falls-Windsor | A2A2C9 |
| Grand Falls-Windsor | A2A2C9 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| St. John's | A1E5X7 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Portugal Cove | A1M1G2 |
| Mt. Pearl | A1N5B5 |
| Grand Falls | A2A2C9 |
| Portugal Cove | A1M2B8 |
| Goose Bay | A0P1E0 |
| Bonavista | A0C1B0 |
| Twillingate | A0G4M0 |
| CBS | A1X3H1 |
| Holyrood | A0A2R0 |
| Goose Bay | A0P1C0 |
| St. John's | A1B2X2 |
| St. John's | A1A5A1 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| Glovertown | A0G2L0 |
| Gander | A1V1E5 |
| Corner Brook | A2H2Y6 |
| St. John's | A1A2M7 |
| St. John's | A1A2M7 |
| Grand Bank | A0E1W0 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B1W3 |
| Brookfield, B. Bay | A0G1J0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| CBS | A1W5T2 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2Y6 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Grand Falls-Windsor | A2A1V8 |
| Stephenville Crossing | A0N2C0 |
| Carbonear | A1Y1A6 |
| Mt. Pearl | A1N5B5 |
| St. Anthony | A0K4S0 |
| St. Anthony | A0K4S0 |
| St. John's | A1A4A5 |
| Stephenville | A2N2Y9 |
| Grand Falls-Windsor | A2A2C9 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Portugal Cove | A1M1G2 |
| Mt. Pearl | A1N5B5 |
| Portugal Cove | A1M2B8 |
| Goose Bay | A0P1E0 |
| Bonavista | A0C1B0 |
| Kelligrews | A0A2T0 |
| Holyrood | A0A2R0 |
| St. John's | A1B2X2 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| Glovertown | A0G2L0 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E5Z6 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Labrador City | A2V1L1 |

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|---|---|
| St. John's | A1E5Z6 |
| Grand Falls-Windsor | A2A2K3 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Mt. Pearl | A1N2C1 |
| Labrador City | A2V1L1 |
| Lumsden | A0G3E0 |
| Gander | A1V2S3 |
| St. John's | A1C6C9 |
| Mt. Pearl | A1N1X6 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1B4J9 |
| St. John's | A1E1P8 |
| Wabush | A0R1B0 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Goose Bay | A0P1E0 |
| Bay Roberts | A0A1G0 |
| Port aux Basque | A0M1C0 |
| St. John's | A1E2Y2 |
| St. John's | A1A2M7 |
| St. John's | A1E4N1 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1BW3 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H6Z1 |
| CBC | A1X3H1 |
| St. John's | A1A1W7 |
| St. John's | A1A2G8 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Clarenville | A5A1R4 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Bay Roberts | A0A1G0 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H2Y6 |
| Lumsden | A0G3E0 |
| Twillingate | A0G4M0 |
| St. John's | A1C6C9 |
| Mt. Pearl | A1N1X6 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Wabush | A0R1B0 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Labrador | A0K2P0 |
| Goose Bay | A0P1E0 |
| Bay Roberts | A0A1G0 |
| Port aux Basque | A0M1C0 |
| St. John's | A1E2Y2 |
| St. John's | A1E2Y2 |
| St. John's | A1A2M7 |
| St. John's | A1E4N1 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| Goose Bay | A0P1C0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1A2G8 |
| St. John's | A1E1P8 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Clarenville | A0E1J0 |
| Gander | A1V1X1 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Bay Roberts | A0A1G0 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| Stephenville | A2M3B9 |
| Manuels | A1W1M8 |
| St. John's | A1E4J8 |
| St. John's | A1E4N1 |
| St. John's | A1B3V6 |

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|---|---|
| Stephenville | A2M3B4 |
| CBS | A1W3A6 |
| St. John's | A1E4J8 |
| St. John's | A1E4N1 |
| St. John's | A1B3V6 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Goose Bay | A0P1C0 |
| Gander | A1V1W5 |
| Goose Bay | A0P1S0 |
| St. John's | A1A4A5 |
| Grand Falls-Windsor | A2A2C9 |
| Mt. Pearl | A1N5B5 |
| Roddickton | A0K4P0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| Burin Bay Arm | A0E1G0 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1A1W7 |
| Bay Roberts | A0A1G0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Goose Bay | A0P1C0 |
| Gander | A1V1W5 |
| Goose Bay | A0P1S0 |
| Mt. Pearl | A1N5B5 |
| Roddickton | A0K4P0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| Burin Bay Arm | A0E1G0 |
| St. John's | A1A1W7 |
| Bay Roberts | A0A1G0 |
| Flowers Cove | A0K2N0 |

| **2002: Community Name** | **2002: Postal Codes** | **2001: Community Name** | **2001: Postal Codes** |
|---|---|---|---|
| Corner Brook | A2H6R6 | Corner Brook | A2H6R6 |
| Carbonear | A1Y1A6 | Goose Bay | A0P1S0 |
| Goose Bay | A0P1E0 | Carbonear | A1Y1A6 |
| Atwater | A0P1E0 | Goose Bay | A0P1E0 |
| St. John's | A1B1W3 | St. John's | A1B1W3 |
| Mt. Pearl | A1N1X6 | St. John's | A1E5Z6 |
| St. John's | A1E5Z6 | St. John's | A1B1W3 |
| St. John's | A1B1W3 | Harbour Grace | A0A2M0 |
| Harbour Grace | A0A2M0 | St. John's | A1B1W3 |
| St. John's | A1B1W3 | Mt. Pearl | A1N2C1 |
| Mt. Pearl | A1N2C1 | Corner Brook | A2H4C7 |
| Corner Brook | A2H4C7 | St. John's | A1A2M7 |
| St. John's | A1A2M7 | Grand Falls-Windsor | A2A1Y8 |
| Grand Falls-Windsor | A2A2J5 | Manuels | A1V1M8 |
| Manuels | A1V1M8 | Grand Falls-Windsor | A2A1V8 |
| Grand Falls-Windsor | A2A1V8 | St. John's | A1B3Y8 |
| St. John's | A1B3Y8 | St. John's | A1E2E2 |
| St. John's | A1E2E2 | St. John's | A1E2E2 |
| St. John's | A1E2E2 | St. John's | A1A4A5 |
| St. John's | A1A4A5 | Goose Bay | A0P1C0 |
| Goose Bay | A0P1C0 | Flowers Cove | A0K2N0 |

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|---|---|
| Flowers Cove | A0K2N0 |
| Manuels | A1W1M8 |
| St. John's | A1A2G8 |
| Grand Falls-Windsor | A2A2S4 |
| St. John's | A1B1R6 |
| St. John's | A1C2H5 |
| Clarenville | A0E1J0 |
| Bay Roberts | A0A1G0 |
| Grand Falls-Windsor | A2A2C9 |
| Paradise | A1L1N9 |
| St. John's | A1A1W7 |
| Mt. Pearl | A1N3J6 |
| St. John's | A1A4A5 |
| Burin Bay Arm | A0E1G0 |
| St. John's | A1A2G8 |
| St. John's | A1A2M7 |
| St. John's | A1A2M7 |
| Grand Bank | A0E1W0 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Manuels | A1W1G8 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Goulds | A1S1H5 |
| Corner Brook | A2H4V6 |
| Gander | A1V1W5 |
| Stephenville Crossing | A0N2C0 |
| Corner Brook | A2H4V6 |
| Carbonear | A1Y1A6 |
| St. John's | A1A4A5 |
| Stephenville | A2N2Y5 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Paradise | A1L1C1 |
| Goose Bay | A0P1E0 |
| Kelligrews | A0A2T0 |
| Holyrood | A0A2R0 |
| St. John's | A1B2X2 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| Gander | A1V1E5 |
| Manuels | A1W1M8 |
| St. John's | A1A2G8 |
| Grand Falls-Windsor | A2A2S4 |
| St. John's | A1B1R6 |
| St. John's | A1C2H5 |
| Clarenville | A0E1J0 |
| Bay Roberts | A0A1G0 |
| Grand Falls-Windsor | A2A2C9 |
| Paradise | A1L1E3 |
| St. John's | A1A1W7 |
| Mt. Pearl | A1N3J6 |
| St. John's | A1A4A5 |
| Burin Bay Arm | A0E1G0 |
| St. John's | A1A2G8 |
| St. John's | A1A2M7 |
| Grand Bank | A0E1W0 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Manuels | A1W1G8 |
| St. Anthony | A0K4S0 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Goulds | A1S1H2 |
| Corner Brook | A2H4V6 |
| Carbonear | A1Y1A6 |
| St. John's | A1A4A5 |
| Stephenville | A2N2Y5 |
| Corner Brook | A2H2Z3 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Paradise | A1L1C1 |
| Goose Bay | A0P1C0 |
| Portugal Cove | A0A3K0 |
| Goose Bay | A0P1E0 |
| Kelligrews | A0A2T0 |
| Bay Roberts | A0A1G0 |
| St. John's | A1B2X2 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |

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|---|---|
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E5Z6 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Holyrood | A0A2R0 |
| Lumsden | A0G3E0 |
| Twillingate | A0G4M0 |
| St. John's | A1C6C9 |
| Mt. Pearl | A1N1X6 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Bay Roberts | A0A1G0 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1E2Y2 |
| St. John's | A1A2M7 |
| St. John's | A1E4N1 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| Goose Bay | A0P1C0 |
| Roddickton | A0K4P0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| Gander | A1V1X1 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| Stephenville | A2M3B9 |
| Manuels | A1W1M8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E5Z6 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Bay Roberts | A0A1G0 |
| Lumsden | A0G3E0 |
| St. John's | A1C6C9 |
| Mt. Pearl | A1N1X6 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| Grand Falls-Windsor | A2A2R6 |
| Mt. Pearl | A1N2C4 |
| Grand Falls-Windsor | A2A1V8 |
| Grand Falls-Windsor | A2A1V8 |
| Torbay | A1K1B2 |
| St. John's | A1A2M7 |
| St. John's | A1E4N1 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| Goose Bay | A0P1C0 |
| Roddickton | A0K4P0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| Gander | A1V2S3 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| Paradise | A1L1C1 |
| Gander | A1V2H2 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| Gander | A1V1X1 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| Stephenville | A2M3B9 |
| Manuels | A1W1M8 |
| St. John's | A1E4J8 |

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|---|---|
| St. John's | A1E4J8 |
| St. John's | A1E4N1 |
| St. John's | A1B3V6 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Gander | A1V2H2 |
| Goose Bay | A0P1S0 |
| Mt. Pearl | A1N5B5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| St. John's | A1A1W7 |
| Bay Roberts | A0A1G0 |

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|---|---|
| St. John's | A1E4N1 |
| St. John's | A1A1R8 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Grand Falls-Windsor | A2A2J4 |
| Mt. Pearl | A1N2M1 |
| St. Anthony | A0K4S0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| St. John's | A1A1W7 |
| Bay Roberts | A0A1G0 |

| **2000: Community Name** | **2000: Postal Codes** |
|---|---|
| Corner Brook | A2H6R6 |
| Goose Bay | A0P1S0 |
| Carbonear | A1Y1A6 |
| Goose Bay | A0P1E0 |
| St. John's | A1B1W3 |
| St. John's | A1E5Z6 |
| Harbour Grace | A0A2M0 |
| St. John's | A1B1W3 |
| Mt. Pearl | A1N1X6 |
| Corner Brook | A2H4C7 |
| St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A1Y8 |
| Manuels | A1V1M8 |
| Grand Falls-Windsor | A2A1V8 |
| St. John's | A1B3Y8 |
| St. John's | A1E2E3 |
| St. John's | A1E2E3 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| Goose Bay | A0P1C0 |
| Flowers Cove | A0K2N0 |
| Manuels | A1W1M8 |
| St. John's | A1A2G8 |
| Grand Falls-Windsor | A2A2C9 |
| St. John's | A1B1R6 |
| St. John's | A1C2H5 |
| Clarenville | A0E1J0 |
| Bay Roberts | A0A1G0 |
| Paradise | A1L1E3 |

| **1999: Community Name** | **1999: Postal Codes** |
|---|---|
| Corner Brook | A2H6R6 |
| Goose Bay | A0P1S0 |
| St. John's | A1E4N1 |
| St. John's | A1E4R6 |
| St. John's | A1B1W3 |
| Mt. Pearl | A1N1X6 |
| Goose Bay | A0P1C0 |
| St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A1Y8 |
| Manuels | A1V1M8 |
| Grand Falls-Windsor | A2A2J8 |
| Goose Bay | A0P1E0 |
| St. John's | A1B3Y8 |
| Mt. Pearl | A1N2X1 |
| Mt. Pearl | A1N2X1 |
| Mt. Pearl | A1N2X2 |
| St. John's | A1A4A5 |
| Goose Bay | A0P1C0 |
| Flowers Cove | A0K2N0 |
| St. John's | A1A2G8 |
| St. John's | A1B1R6 |
| St. John's | A1C2H5 |
| Clarenville | A0E1J0 |
| Bay Roberts | A0A1G0 |
| Paradise | A1L1E3 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| St. John's | A1E2C5 |
| St. John's | A1A4A5 |

| | |
|---|---|
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| St. John's | A1E2C5 |
| St. John's | A1A4A5 |
| St. John's | A1A2G8 |
| St. John's | A1A2M7 |
| Grand Bank | A0E1W0 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Manuels | A1W1N2 |
| St. Anthony | A0K4S0 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Goulds | A1S1H2 |
| Gander | A1V1W5 |
| Stephenville Crossing | A0N2C0 |
| Carbonear | A1Y1A6 |
| St. John's | A1A4A5 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Z3 |
| St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Paradise | A1L1C1 |
| Goose Bay | A0P1C0 |
| Wesleyville | A0G4R0 |
| Goose Bay | A0P1E0 |
| Kelligrews | A0A2T0 |
| Bay Roberts | A0A1G0 |
| St. John's | A1B2X2 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| St. John's | A1B1W3 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E5Z6 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1A2G8 |
| St. John's | A1A2M7 |
| St. John's | A1C2H5 |
| St. Anthony | A0K4S0 |
| St. John's | A1B1W3 |
| Corner Brook | A2H4C7 |
| Harbour Grace | A0A2M0 |
| Manuels | A1W1N2 |
| St. Anthony | A0K4S0 |
| Goose Bay | A0P1C0 |
| Stephenville | A2N2M9 |
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Goulds | A1S1H2 |
| Gander | A1V1W5 |
| Stephenville Crossing | A0N2C0 |
| Carbonear | A1Y1A6 |
| St. John's | A1A4A5 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Z3 |
| St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Torbay | A1K1A2 |
| Goose Bay | A0P1C0 |
| Wesleyville | A0G4R0 |
| Goose Bay | A0P1E0 |
| Kelligrews | A0A2T0 |
| Bay Roberts | A0A1G0 |
| St. John's | A1C2H5 |
| St. John's | A1B1W3 |
| St. John's | A1B1W8 |
| St. John's | A1B1W3 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E4N1 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Corner Brook | A2H6Y5 |
| Bay Roberts | A0A1G0 |
| Lumsden | A0G3E0 |

| | |
|---|---|
| St. John's | A1B1W3 |
| Bay Roberts | A0A1G0 |
| Lumsden | A0G3E0 |
| St. John's | A1C6C9 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1H2 |
| St. John's | A1B2X2 |
| Grand Falls-Windsor | A2A2R6 |
| Grand Falls-Windsor | A2A1V8 |
| St. Anthony | A0L4S0 |
| Torbay | A1K1B2 |
| St. John's | A1A2M7 |
| St. John's | A1C2H2 |
| St. John's | A1B4S8 |
| Roddickton | A0K4P0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| St. John's | A1C2H2 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Grand Falls-Windsor | A2A1Y8 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| St. John's | A1C2H1 |
| Gander | A1V1X1 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| Stephenville | A2M3B9 |
| Goose Bay | A0P1C0 |
| Goose Bay | A0P1C0 |
| Goose Bay | A0P1C0 |
| Manuels | A1W1M8 |
| St. John's | A1E4J8 |
| St. John's | A1A1R8 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1K9 |
| Grand Falls-Windsor | A2A2J4 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1C6C9 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1E4 |
| St. John's | A1B2X2 |
| Grand Falls-Windsor | A2A2R6 |
| St. John's | A1B1W3 |
| Torbay | A1K1B2 |
| St. John's | A1A2M7 |
| St. John's | A1C2H2 |
| Roddickton | A0K4P0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| St. John's | A1N1W1 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| Corner Brook | A2H1C3 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| Stephenville | A2M3B9 |
| Goose Bay | A0P1C0 |
| Gander | A1V1X1 |
| Manuels | A1W1M8 |
| St. John's | A1E4J8 |
| St. John's | A1A1R8 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1E4 |
| Grand Falls-Windsor | A2A2J4 |
| Mt. Pearl | A1N1X6 |
| Mt. Pearl | A1N2M1 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| St. John's | A1A1W7 |

| | |
|---|---|
| Mt. Pearl | A1N2M1 |
| St. Anthony | A0K4S0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| St. John's | A1A1W7 |

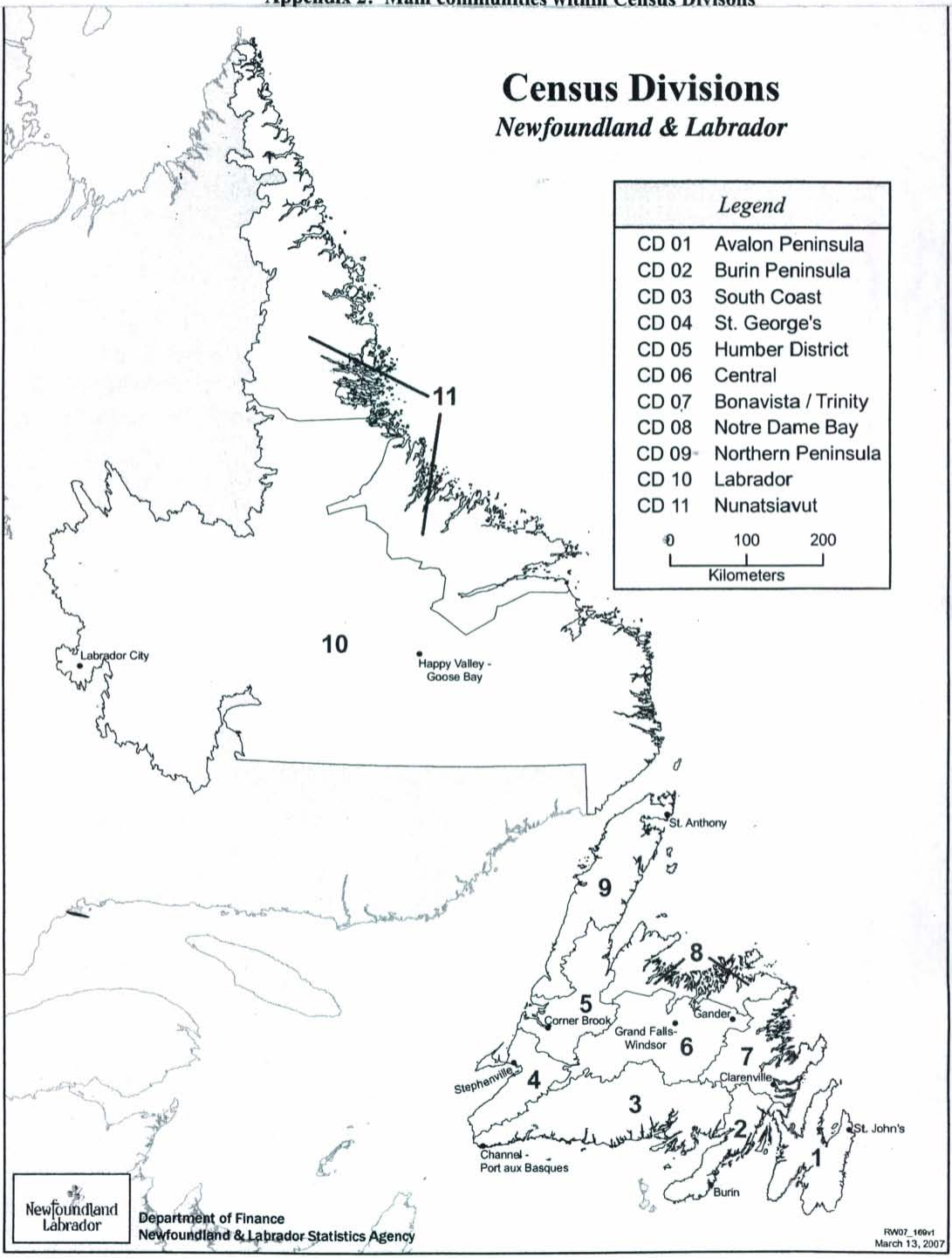
| 1998: Community Name | 1998: Postal Codes | 1997: Community Name | 1997: Postal Codes |
|---|---|---|---|
| Corner Brook | A2H6R6 | Corner Brook | A2H6R6 |
| Manuals | A1W1N2 | Manuals | A1W1N2 |
| CFB Goose Bay | A0P1S0 | CFB Goose Bay | A0P1S0 |
| St. John's | A1E4N1 | St. John's | A1E4N1 |
| St. John's | A1B3Y8 | St. John's | A1B3Y8 |
| St. John's | A1B1W3 | St. John's | A1B1W3 |
| Mt. Pearl | A1N1X6 | Mt. Pearl | A1N1X6 |
| Goose Bay | A0P1C0 | Goose Bay | A0P1S0 |
| St. John's | A1A2M7 | St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A1Y8 | Grand Falls-Windsor | A2A1Y8 |
| Grand Falls-Windsor | A2A1Y8 | Grand Falls-Windsor | A2A1Y8 |
| Grand Falls-Windsor | A2A2J8 | Grand Falls-Windsor | A2A2J8 |
| Goose Bay | A0P1S0 | Goose Bay | A0P1S0 |
| St. John's | A1B3Y8 | St. John's | A1B3Y8 |
| Mt. Pearl | A1N2X1 | Mt. Pearl | A1N2X1 |
| Mt. Pearl | A1N2X1 | Mt. Pearl | A1N2X1 |
| Mt. Pearl | A1N2X2 | Mt. Pearl | A1N2X2 |
| St. John's | A1A4A5 | St. John's | A1A4A5 |
| Goose Bay | A0P1S0 | Goose Bay | A0P1S0 |
| Flowers Cove | A0K2N0 | Flowers Cove | A0K2N0 |
| St. John's | A1A2G8 | St. John's | A1A2G8 |
| St. John's | A1C2H1 | St. John's | A1C2H1 |
| St. John's | A1B1R6 | St. John's | A1B1R6 |
| St. John's | A1C2H5 | St. John's | A1C2H5 |
| Clarenville | A0E1J0 | Clarenville | A0E1J0 |
| Bay Roberts | A0A1G0 | Bay Roberts | A0A1G0 |
| Stephenville | A2N3A3 | Stephenville | A2N3A3 |
| St. John's | A1A1W7 | St. John's | A1A1W7 |
| St. John's | A1E1P8 | St. John's | A1E1P8 |
| St. John's | A1E2C5 | St. John's | A1E2C5 |
| St. John's | A1A4A5 | St. John's | A1A4A5 |
| St. John's | A1A2G8 | St. John's | A1A2G8 |
| St. John's | A1A2M7 | St. John's | A1A2M7 |
| St. John's | A1C2H5 | St. John's | A1C2H5 |
| St. John's | A1B1W3 | St. John's | A1B1W3 |
| Corner Brook | A2H4C7 | Corner Brook | A2H4C7 |
| Harbour Grace | A0A2M0 | Harbour Grace | A0A2M0 |
| Stephenville | A2N2M9 | Stephenville | A2N2M9 |

| | |
|---|---|
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Grand Falls-Windsor | A2A2C9 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Y6 |
| Carbonear | A1Y1A6 |
| St. John's | A1A4A5 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Z3 |
| St. John's | A1A2M7 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H5M7 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Torbay | A1K1A2 |
| Goose Bay | A0P1S0 |
| Wesleyville | A0G4R0 |
| Kelligrews | A0A2T0 |
| St. John's | A1C2H5 |
| St. John's | A1B1W3 |
| St. John's | A1A4A5 |
| St. John's | A1B1W3 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E4N1 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Corner Brook | A2H6Y5 |
| Lumsden | A0G3E0 |
| Grand Falls-Windsor | A2A2R6 |
| Pasadena | A0L1K0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1E4 |
| St. John's | A1B2X2 |
| Grand Falls-Windsor | A2A2R6 |
| St. John's | A1B1W3 |
| St. John's | A1E2Y2 |
| St. John's | A1A2M7 |
| St. John's | A1C2H2 |
| Roddickton | A0K4P0 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2P5 |
| Placentia | A0B 2Y0 |
| St. John's | A1E4N1 |
| Grand Falls-Windsor | A2A2C9 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Y6 |
| Carbonear | A1Y1C4 |
| St. John's | A1A4A5 |
| Gander | A1V1W5 |
| Corner Brook | A2H2Z3 |
| St. John's | A1E4B2 |
| Grand Falls-Windsor | A2A2C9 |
| Corner Brook | A2H1R6 |
| Bay Roberts | A0A1G0 |
| Corner Brook | A2H4B5 |
| Gander | A1V1W5 |
| Holyrood | A0A2R0 |
| Torbay | A1K1A2 |
| Carbonear | A1Y1C4 |
| Wesleyville | A0G4R0 |
| Kelligrews | A0A2T0 |
| St. John's | A1C2H5 |
| St. John's | A1B1W3 |
| St. John's | A1A4A5 |
| Gander | A1V1E5 |
| Mt. Pearl | A1N1B8 |
| Corner Brook | A2H2w9 |
| St. John's | A1E4N1 |
| Lewisporte | A0G3A0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1C2H5 |
| Mt. Pearl | A1N1X6 |
| St. John's | A1B1W3 |
| Corner Brook | A2H6Y5 |
| Lumsden | A0G3E0 |
| Burin Bay Arm | A0E1G0 |
| St. John's | A1C6C9 |
| Grand Falls-Windsor | A2A2R6 |
| Deer Lake | A0K2E0 |
| St. John's | A1E1P8 |
| Labrador City | A2V1L1 |
| Torbay | A1K1E4 |
| St. John's | A1B2X2 |
| Grand Falls-Windsor | A2A2R6 |
| Goulds | A1S1G8 |
| St. John's | A1A2M7 |
| St. John's | A1C2E4 |
| St. John's | A1B1W3 |
| Harbour Grace | A0A2M0 |
| Corner Brook | A2H2Y6 |

| | |
|---|---|
| Corner Brook | A2H2Y6 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| St. John's | A1N1W1 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| Corner Brook | A2H1C3 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H6Y5 |
| St. John's | A2N2M9 |
| Goose Bay | A0P1S0 |
| Gander | A1V1X1 |
| Manuels | A0A2Y0 |
| St. John's | A1E4J8 |
| St. John's | A1A1R8 |
| Bay Roberts | A0A1G0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1E4 |
| Grand Falls-Windsor | A2A2J4 |
| Mt. Pearl | A1N1X6 |
| Mt. Pearl | A1N2M1 |
| Goose Bay | A0P1C0 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1C6C9 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |
| Grand Falls-Windsor | A2A2R6 |
| Springdale | A0J1T0 |
| Deer Lake | A0K2E0 |
| Deer Lake | A0K2E0 |
| Carbonear | A1Y1A4 |
| Burin Bay Arm | A0E1G0 |
| Grand Bank | A0E1W0 |
| St. Anthony | A0K4S0 |
| St. Anthony | A0K4S0 |
| St. Anthony | A0K4S0 |
| Bonavista | A0C1B0 |
| Glovertown | A0G2L0 |
| Labrador City | A2V1L1 |
| St. John's | A1C2H1 |
| St. John's | A1C2H1 |
| St. John's | A1N1W1 |
| Corner Brook | A2H6Z1 |
| Kelligrews | A0A2T0 |
| St. John's | A1A1W7 |
| St. John's | A1E1P8 |
| Gander | A1V2H2 |
| Stephenville | A2N2M9 |
| St. John's | A1C2H1 |
| Whitbourne | A0B2K0 |
| Corner Brook | A2H1C3 |
| Norris Point | A0K3V0 |
| Corner Brook | A2H2L2 |
| Goose Bay | A0P1S0 |
| Gander | A1V1X1 |
| Manuels | A0A2Y0 |
| St. John's | A1E4J8 |
| St. John's | A1A1R8 |
| Bay Roberts | A0A1G0 |
| Mt. Pearl | A1N1W1 |
| St. John's | A1A3R5 |
| St. John's | A1E4N1 |
| Torbay | A1K1E4 |
| Grand Falls-Windsor | A2A2J4 |
| Mt. Pearl | A1N1X6 |
| Mt. Pearl | A1N2M1 |
| St. John's | A1B2X2 |
| St. John's | A1A4A5 |
| St. John's | A1A1W8 |
| St. John's | A1E3B2 |
| St. John's | A1C2H5 |
| St. John's | A1B2X2 |

| | |
|---|---|
| Twillingate | A0G4M0 |
| Wabush | A0R1B0 |
| Port aux Basques | A0M1C0 |
| Clarenville | A0E1J0 |
| Burin Bay Arm | A0E1G0 |

**Appendix 2: Main communities within Census Divisons**



## Appendix 3: Population projections and dental ratio

Population Projections by Census Division

| CD | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1001 | 251, 523 | 249, 793 | 248, 063 | 246, 333 | 244, 603 | 242, 875 | 243, 799 | 244, 723 | 246, 571 | 247, 495 | 248, 418 |
| 1002 | 27, 723 | 27, 053 | 26, 383 | 25, 713 | 25, 043 | 24, 371 | 23, 886 | 23, 471 | 22, 641 | 22, 226 | 22, 298 |
| 1003 | 22, 459 | 21, 841 | 21, 223 | 20, 605 | 19, 987 | 19, 370 | 19, 089 | 18, 808 | 18, 246 | 17, 965 | 17, 686 |
| 1004 | 24, 824 | 24, 292 | 23, 760 | 23, 228 | 22, 696 | 22, 164 | 21, 996 | 21, 830 | 21, 498 | 21, 332 | 21, 168 |
| 1005 | 44, 319 | 39, 695 | 38, 924 | 38, 153 | 37, 382 | 40, 466 | 40, 523 | 40, 580 | 40, 694 | 40, 751 | 40, 805 |
| 1006 | 39, 118 | 38, 536 | 37, 954 | 37, 372 | 36, 790 | 36, 208 | 36, 208 | 36, 208 | 36, 208 | 36, 208 | 36, 208 |
| 1007 | 41, 534 | 40, 694 | 39, 854 | 39, 014 | 38, 174 | 37, 335 | 37, 029 | 36, 724 | 36, 114 | 35, 809 | 35, 501 |
| 1008 | 48, 247 | 47, 035 | 45, 823 | 44, 611 | 43, 399 | 42, 188 | 41, 646 | 41, 104 | 40, 020 | 39, 478 | 38, 937 |
| 1009 | 22, 855 | 22, 302 | 21, 749 | 21, 196 | 20, 643 | 20, 091 | 19, 756 | 19, 421 | 18, 751 | 18, 416 | 18, 084 |
| 1010 | 29, 190 | 28, 398 | 27, 606 | 26, 814 | 26, 022 | 25, 230 | 25, 017 | 24, 804 | 24, 378 | 24, 165 | 23, 950 |