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Socioeconomic burden of replantation of avulsed permanent maxillary incisors of children and adolescents

by

Phu-My T. Nguyen, B.Sc., D.D.S.

A thesis submitted in conformity with the requirements for the degree of Master of Science
Faculty of Dentistry
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Socioeconomic burden of replantation of avulsed permanent maxillary incisors of children and adolescents

Master of Science 2000
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Abstract

This study describes the socioeconomic burden on children (and their families) whose avulsed permanent maxillary incisors were replanted. Complete records for a minimum of one year were obtained for 43 patients (60 replanted incisors) treated at The Hospital for Sick Children from 1988 to 1999. Mean age at time of injury was 10.6 years (range = 6.6-17.7). First-year mean treatment provided included 5.5 diagnostic periapical radiographs, 1.3 pulpectomies, and 2.7 pulp medication applications. First year mean treatment cost (1465 CAD) and direct time (7.2 hours) was estimated. Survey of 21 patient-parent pairs demonstrated that the drive to request replantation is very strong in both parents and children in that a majority of patients (67%) and parents (81%) stated they would have still made the same replantation decision. This study describes the burden of the decision to replant on both children and their families and increases information for consent purposes.

Key Words: permanent incisor, avulsion, replantation, socioeconomic costs, quality of life
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Introduction

Avulsion injuries are rare compared to other dentoalveolar injuries (Ravn, 1974; Oikarinen et al., 1987; Glendor et al., 1996). However, since most avulsion injuries occur in children and pre-adolescents, multiple family members are also affected. In addition, facial growth often dictates that definitive treatment be delayed for several years.

Although outcome studies of avulsion/replantation injuries have been published, the social and economic burden of these injuries have not yet been specifically investigated. Patients and parents need to understand the responsibilities, costs and expected outcomes when considering replantation of avulsed incisor(s).
Literature Review

Epidemiology of dental avulsions

Kaste et al. (1996) reported that in the United States, the prevalence of all injuries to maxillary and/or mandibular incisors was 25 per cent. This was lower than the United Kingdom (UK) and Denmark where prevalence ranged between 30 and 40 per cent (Hamilton et al., 1997a; Andreasen and Ravn, 1972). The majority of dental injuries are sustained between the ages of 8 and 12 years (Mackie and Worthington, 1993; Ravn, 1974; Marcenes et al., 1999). Glendor et al. (1996) reported that 83 per cent of all individuals with tooth injuries were younger than 20 years. Thus, childhood and adolescence is the most vulnerable period for incisor injuries and over one quarter of these youths can be expected to sustain injuries to their front teeth.

Table 1 demonstrates that maxillary central incisors are most at risk for avulsion. Tables 2 and 3 illustrate the incidence and prevalence of avulsed teeth in children and adolescents. Incidence, the number of new cases per year, ranges from 0.5 to 2.5 per cent. Prevalence, the number of people in a population who have avulsed permanent teeth, ranges from 0.5 to 9 per cent of all dental injuries. The wide range of prevalence is due to variations in the populations sampled. For instance, Fleming et al. (1991), Liew and Daly (1986), Barrett (1995) and Sae-Lim and Yuen (1997) showed higher prevalence in samples that were drawn from hospital populations where patients with more severe injuries present for care. Zerman and Cavalleri (1993) did not specify the hours of operation of their university emergency dental clinic but the prevalence reported approached that of most 24-hour hospital clinics.
Table 1: Distribution of maxillary incisor avulsions

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Central Incisor (%)</th>
<th>Lateral Incisor (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mackie &amp; Worthington (1993)</td>
<td>93</td>
<td>7</td>
</tr>
<tr>
<td>Zerman &amp; Cavalleri (1993)</td>
<td>77</td>
<td>15</td>
</tr>
<tr>
<td>Kaste et al. (1996)</td>
<td>61</td>
<td>16</td>
</tr>
<tr>
<td>Glendor et al. (1996)</td>
<td>73</td>
<td>11</td>
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</tbody>
</table>

Table 2: Incidence of avulsed teeth in children and adolescents

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>Incidence (%)</th>
<th>Age Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ravn (1974)</td>
<td>0.5</td>
<td>6-19 years</td>
</tr>
<tr>
<td>Oikarinen et al. (1987)</td>
<td>2</td>
<td>7-10 years</td>
</tr>
<tr>
<td>Glendor et al. (1996)</td>
<td>1.5: 2.5</td>
<td>male: female (5-19 years)</td>
</tr>
</tbody>
</table>
Table 3: Comparison of prevalence of avulsion injuries among different countries

<table>
<thead>
<tr>
<th>Author (Year)</th>
<th>% Of Permanent Trauma (n)</th>
<th>Age Range (years)</th>
<th>Period Data Collected</th>
<th>Country Collected</th>
<th>In Operation</th>
<th>Clinic Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ravn (1974)</td>
<td>0.5 (12 989)</td>
<td>6-17</td>
<td>5 years</td>
<td>Denmark</td>
<td>24 hrs</td>
<td>DPH, hospital</td>
</tr>
<tr>
<td>Garcia-Godoy et al. (1985)</td>
<td>2.3 (172)</td>
<td>6-17</td>
<td>N/A</td>
<td>Dominican Republic</td>
<td>N/A</td>
<td>School pop.</td>
</tr>
<tr>
<td>Liew &amp; Daly (1986)</td>
<td>11.2 (392)</td>
<td>0-44</td>
<td>2 years</td>
<td>Australia</td>
<td>After hours</td>
<td>Hospital</td>
</tr>
<tr>
<td>Oikarinen &amp; Kassila (1987)</td>
<td>0.9 (1508)</td>
<td>1-20</td>
<td>2 years</td>
<td>Finland</td>
<td>Daytime service only</td>
<td>DPH</td>
</tr>
<tr>
<td>Stockwell (1988)</td>
<td>0.4 (1365)</td>
<td>6-12</td>
<td>1 year</td>
<td>Australia</td>
<td>N/A</td>
<td>DPH</td>
</tr>
<tr>
<td>Majewski et al. (1988)</td>
<td>6.2 (176)</td>
<td>0-31</td>
<td>1 year</td>
<td>U.S.A.</td>
<td>After hours</td>
<td>Pediatric hospital</td>
</tr>
<tr>
<td>Kaba &amp; Maréchaux (1989)</td>
<td>5.2 (444)</td>
<td>6-18</td>
<td>14 years</td>
<td>Switzerland</td>
<td>N/A</td>
<td>Univ. pediatric dental clinic</td>
</tr>
<tr>
<td>Forsberg &amp; Tedestam (1990)</td>
<td>0.8 (364)</td>
<td>7-15</td>
<td>1 year</td>
<td>Sweden</td>
<td>N/A</td>
<td>DPH</td>
</tr>
<tr>
<td>Fleming et al. (1991)</td>
<td>8.9 (56)</td>
<td>0-13</td>
<td>1 year</td>
<td>Ireland</td>
<td>After hours</td>
<td>Pediatric hospital</td>
</tr>
<tr>
<td>Zerman &amp; Cavalleri (1993)</td>
<td>8.6 (326)</td>
<td>6-21</td>
<td>5 years</td>
<td>Italy</td>
<td>N/A</td>
<td>Univ. emerg. clinic</td>
</tr>
<tr>
<td>Barrett (1995)</td>
<td>11 (1407)</td>
<td>&lt;18*</td>
<td>5 years</td>
<td>Canada</td>
<td>24 hours</td>
<td>Pediatric hospital</td>
</tr>
<tr>
<td>Sae-Lim &amp; Yuen (1997)</td>
<td>25 (134 periodontal injuries)</td>
<td>*</td>
<td>5 years</td>
<td>Singapore</td>
<td>After hours</td>
<td>Hospital</td>
</tr>
<tr>
<td>Lygidakis et al. (1998)</td>
<td>1 (221)</td>
<td>8 mos - 12 yrs</td>
<td>1 year</td>
<td>Greece</td>
<td>Daytime service only</td>
<td>Pediatric dental clinic</td>
</tr>
</tbody>
</table>

N/A – not applicable; M-F – Monday to Friday; DPH – dental public health clinic

*not specified
Management of dental avulsions

First-aid management of avulsions is almost exclusively provided by non-dental personnel. Hamilton et al. (1997c) reported on a survey of physical education teachers, school nurses, swimming pool attendants, recreational attendants and parents of teenagers. Eighty per cent of respondents stated that they personally would not want to replant an avulsed incisor. The bleeding, crying and associated disruption of an avulsion consistently dissuades caregivers from intervention beyond storage of the tooth and transportation of the patient to a hospital or dental office.

Community dentists seldom treat avulsion injuries and therefore rely upon their memory or published guidelines for management since their experience is limited. The American Association of Endodontists (AAE) (1995) and The Royal College of Surgeons of England (RCSE) (1998) have produced consensus-based guidelines for the clinical management of avulsed teeth. The RCSE has published the only evidence-based guideline. Barrett and Kenny (1997b) emphasized that none of the available guidelines have been tested by clinical trials or contains specific outcome information. They also noted that explanation of risk/benefit was not included in the AAE guidelines.

(Matsson et al., 1982), doxycycline soak (Cvek et al., 1990) and stannous fluoride application (Selvig et al., 1992). None of these recommendations are supported by human studies.

The rationale of clinical guidelines must be understood in order to understand the effects of guidelines on clinical outcomes. Outcomes must be considered from clinical, patient and parental perspectives (Bader and Shugars, 1995). Treatment outcomes include:

1. Pain, transitory loss of function, pulpal and periodontal pathosis
2. Perceived esthetics, level of oral health, satisfaction with oral health status, self-concept and interpersonal relations
3. Economics: direct and indirect costs
4. Survival: pulpal necrosis, multiple treatments for the same condition, treatment of new condition, extraction.

The available clinical guidelines do not address patient-related outcomes such as the socioeconomic consequences of the decision to replant an incisor.

*Pre-treatment-related variables*

Survival of replanted incisors is based on both injury- and treatment-related variables. Pre-treatment-related variables affect how the patient presents to the dentist following an avulsion. These variables include extra-alveolar duration of the tooth, transportation storage medium, stage of root development and patient’s age at the time of avulsion.
Clinical outcomes and in vitro investigations of cell pathophysiology both show that immediate replantation (within 5 to 10 minutes) is the decisive factor for periodontal ligament (PL) regeneration following replantation (Andersson and Bodin, 1990; Andreasen et al., 1995d; Lekic et al., 1996; Lin et al., 2000). Extended extra-alveolar duration (>10 minutes) decreases the likelihood of PL regeneration and favors repair with scarring and ankylosis. Desiccation prior to replantation produces severe damage to progenitor cells on the root-side PL within fifteen minutes and PL cell death within 30 minutes (Lekic et al., 1996; Söder et al., 1977).

An important factor in the development of inflammatory root resorption (IRR) is the type of interim storage medium that was used. An optimal storage medium should preserve the viability, mitogenicity and clonogenic capacity of the PL cells. Recommended media that are readily available include milk, saliva and water (Layug et al., 1998). Chilled milk is preferred as it preserves the vitality of PL cells on avulsed teeth beyond 2 hours (Lindskog and Blomlöf, 1982, Lekic et al., 1996; Olson et al., 1997). Prevention of desiccation of PL cells is critical. If immediate replantation cannot be accomplished, then storage in saliva or water is recommended until a more suitable medium such as milk can be obtained.

Stage of root development (Fig. 1) is often classified according to Moorrees et al. (1963) later modified by Andreasen et al. (1995a). Stage 2, 3 and 4 (see Fig. 1) are classified as immature root formation and include open (immature) apices and root lengths of one-half, three-quarters, and full length respectively. Stages 5 and 6 are classed as mature root formation where stage 5 represents full root length half-open apex and stage 6 represents full root length with a mature apex. Inflammatory root resorption has
been shown primarily to affect replanted incisors with immature root formation whereas ankylosis affects replanted incisors with mature root formation (Andreasen et al., 1995a). In a study of pediatric patients, replanted incisors with immature root formation demonstrated a relative risk of failure 4.2 times greater than incisors with mature roots and maturing apices (5, 6) (Barrett and Kenny, 1997a). This investigation consisted of incisors whose replantation was delayed (mean extra-alveolar duration was 123 minutes) and the risk of failure is in agreement with the study of replantations with extended extra-alveolar storage by Andersson et al. (1989). Andersson and colleagues (1989) observed that a replanted tooth with a necrotic PL (dry storage of 60 minutes or more) became resorbed within 3 to 7 years in 8-16 year olds, whereas in older patients, similar teeth remained functional for decades. The higher rate of bone remodeling in younger patients is the presumed cause of increased rate of root resorption.

![Fig. 1: Classification of stages of root formation (modified from Moorrees et al., 1963)](image)

The patient’s age may affect the rate of root resorption of replanted teeth. Andersson and colleagues investigated the rate of root resorption in replanted teeth by comparing an extra-alveolar duration of less than 15 minutes (1990) with a duration of greater than 1 hour (1989). Young patients (8-16 years) developed significantly higher rates of root resorption for teeth replanted after one hour compared with older patients.
(17-39 years) (Andersson et al., 1989). Age (range 7-29 years) did not affect root resorption of teeth replanted within 15 minutes (Andersson and Bodin, 1990).

In a clinical study by Andreasen et al. (1995a), the age range was 5 to 52 years with a mean of 13.7 years. Andreasen and colleagues grouped patient age distribution into 3 groups: less than 9 years old, 9-15 years old and greater than 16 years. Their age grouping more accurately reflects root development (stages by Moorrees et al., 1963) than that of Andersson et al. (1989, 1990). The first group (less than 9 years old) corresponds with Moorrees’ stages 2 to 4, the second group (9-15 years old) with Moorrees’ stages 4 to 6 and the third group (greater than 16 years old) with Moorrees’ stage 6. The study by Andreasen et al. (1995a) stated that there was a trend for poorer PL repair in patients over 16 years ($p = 0.01$), However there was no clarification of the type of root resorption. Inflammatory root resorption would lead to extraction whereas ankylosis would allow the tooth to remain functional for an extended period of time.

**Treatment-related variables**

Treatment-related variables include antibiotic coverage, duration/type of fixation, duration/type of root canal medication and endodontic treatment. Of these variables, antibiotics and type of splint (i.e., composite, cap splints, orthodontic splints, etc.) were not significantly related to PL healing (Sae-Lim and Yuen, 1997; Andreasen et al., 1995d). Human studies of antibiotic treatment remain inconclusive (Sae-Lim and Yuen, 1997; Kling et al., 1986) due to small sample sizes and/or too many variables involved. There are no clinical studies of the effects of antibiotic use on healing following replantation. Splinting duration of 10 days or less is believed to reduce the occurrence of
ankylosis and replacement resorption (Andreasen et al., 1995d; Hammarström et al., 1989; Kinirons et al., 1999). Completion of endodontic treatment has been demonstrated to be a significant variable in the survival of avulsed incisors. Kinirons et al. (1999) observed that 26 per cent of replanted incisors developed inflammatory root resorption if the pulp was extirpated beyond 20 days post-replantation. Completion of endodontic obturation produced a 0.86 probability of 5-year survival whereas cases that were not obturated had a 0.35 probability of survival (Barrett and Kenny, 1997a).

In summary, incisors with mature roots replanted immediately and completed endodontic treatment have a better prognosis than incisors with immature roots transported in suboptimal storage media, delayed replantation (greater than 15 minutes) and incomplete endodontic treatment.

**Clinical outcomes of replantation**

The goal of replantation of avulsed teeth is PL regeneration. However, periodontal regeneration will likely never occur in a clinical situation following delayed replantation because the trauma always injures the innermost layer of the PL (Andreasen and Andreasen, 1994) and extraoral storage damages root surface PL cells. Root resorption is neither a healing nor regenerative process. It is a reparative process that attempts to repair the damaged PL by inflammatory or replacement resorption.

Two prospective studies describe clinical outcomes following avulsion injuries. The study of 400 replantations by Andreasen et al. (1995a) utilized standard life tables to estimate survival curves. They reported a 70 per cent retention (survival) rate. Barrett and Kenny (1997a) used survival analysis in an exclusively pediatric population (8-16 years
old) and reported 65 per cent 5-year survival for delayed replantation cases. Both of these studies demonstrated higher failure rates in replanted incisors with immature roots (stage 2 to 4, Moorrees et al.) than those with mature roots (stage 5 and 6, Moorrees et al.).

Ankylosis (replacement root resorption) is a process in which bone grows across the periodontal space and joins with the root. Animal studies (Hammarström et al., 1989) demonstrated ankylosis by 8 weeks in teeth experimentally replanted after an extra-alveolar period of one hour. In clinical studies, ankylosis was the most frequent PL complication and could be demonstrated by 6 months to one year following replantation.

Replantation requires continued treatment and long-term follow-up. Clinical complications include pulp necrosis, periapical pathosis, pain, ankylosis, root resorption infraocclusion and gingival recession. In addition, ongoing treatment such as endodontic revision, restoration replacement, orthodontic treatment, extraction and prosthetic replacement may be required.

Children and adolescents are most vulnerable to dental trauma and their injuries occur in immature incisors. Both factors complicate treatment as ankylosis and subsequent infraaposition of the incisor may be expected as alveolar growth continues. There is a greater risk of infraocclusion if ankylosis occurs before the pubertal growth spurt (Steiner, 1997). Growth distribution curves indicate that the adolescent growth spurt occurs in females between 10.5-13 years and in males 12.5-15 years (Tanner, 1962). Average cumulative normal eruption (9-25 year old females) for maxillary incisors was 6 mm incisally and 2.5 mm labially (Iseri and Solow, 1996).

Ebeleseder et al. (1998) demonstrated a statistically higher alveolar growth arrest among immature and mature teeth in adolescents compared with mature teeth in adults.
For every 10 cm of linear growth, there was alveolar growth arrest of 1.4 and 0.8 mm in adolescents with ankylosed immature or mature roots respectively. This study estimated the annual loss of root structure based on corrected superimpositions of non-standardized radiographs and photographs. Longitudinal superimposition requires established fixed parameters that are reproducible over time for reference (Ranly, 1988). There were several variable factors not accounted for by superimpositioning such as inter- and intra-rater reliability of reference point locator and measurer and non-standardization of photographs. Measurement precision was not discussed in this study yet infraposition was measured in tenths of millimeters. In addition, this study did not describe the reference point used to measure degree of infraposition. The mean age at the time of investigation of the group of patients with immature roots was 10.75±2.22. Therefore, some of the younger patients in this age range may have partially erupted incisors and thus the relative degree of infraposition would be difficult to determine.

The study by Kawanami et al. (1999) (follow-up of the 1995 study series by Andreasen’s et al.) measured the extent of infraposition of replanted avulsed teeth. This study, based on study models of 52 patients, showed significant (p<0.05) age and gender differences in the degree of infraposition. Significantly greater infraposition occurred in 9-15 year olds as compared to those greater than 16 years. Fourteen-year old males demonstrated greater infraposition than their female counterparts. This is consistent with the pubertal growth spurt differences between males and females. This study was more accurate than Ebeleseder et al. (1998) because reference occlusal plane and consistent hard tissue reference points from a non-injured incisor were described. Again, since infraposition is measured in millimeters, standardized photographic set-up of the models
were used, the negatives were magnified 50 times and the degree of infraposition was measured using a digital caliper.

Suboptimal storage conditions, extended extra-alveolar duration, root immaturity, and financial considerations may not be contraindications for replantation but they should be recognized as risk factors for survival. Replantation of avulsed teeth is often a temporary measure and particularly so in adolescents (Andreasen et al., 1995a-d; Barrett and Kenny, 1997a). The study by Andreasen et al. reported a larger sample (400 incisors) than did the study by Barrett and Kenny (52 incisors). However Andreasen et al. had a higher mean age and wider age range (mean = 13.7 years; range = 5-52 years) than Barrett and Kenny (mean = 10.7 years; no range was given but this study is based exclusively on pediatric and adolescent patients). Andreasen et al. reported higher success rates (defined as incisor retention and absence of inflammatory root resorption) than Barrett and Kenny and this is likely due to the older population in the sample population of Andreasen et al.. As explained earlier, an older sample population would have more patients with mature root development, completion of endodontic treatment and a slower rate of root resorption. In addition, the four-part study by Andreasen et al. (1995a-d) indicated that the sample population was 400 incisors, the actual sample size varied in each section (400, 30, 110 and 272 incisors respectively). Several variables were investigated in all four sections of study by Andreasen et al. and therefore the statistical power was likely compromised from multiple testing. In contrast, Barrett and Kenny's study, with a smaller sample size investigated fewer variables (selected variables determined from proportional hazards regression) and produced a stronger statistical
study. These two studies are the only outcome studies that provide information on survival and probabilities of pulp necrosis, root resorption and ankylosis.

Retaining ankylosed replanted teeth and the associated alveolar growth produces aberrant gingival contours (Kokich et al., 1984, Tripodakis et al., 1991), alveolar ridge defect (Steiner, 1997), space loss and disparities in occlusion (Becker et al., 1992a, b). The localized arrest of alveolar bone formation around the ankylosed replanted incisor complicates future implant and/or prosthetic replacement, often requiring orthodontic treatment to correct midlines and regain space (Steiner, 1997; Thilander et al., 1999).

Socioeconomic outcomes of replantation

Studies of the socioeconomic consequences of avulsion/replantation and dental trauma generally are scarce. The costs of replantation have never been specifically quantified except for a very small sample (n = 3; Solli et al., 1996). Additionally, it is difficult to compare costs internationally since materials, overhead costs and procedures vary.

Emergency treatment of dental avulsion injuries is often emotionally charged for children, parents and dentists. Immediate personal considerations include pain, fear of loss of incisors, appearance, concern for concomitant injuries, and guilt. Elias and Sheiham’s (1998) review of dental satisfaction reported that esthetics is more important than function to patients and there is a higher perceived need to replace incisors than less visible posterior teeth. Albino et al. (1984) reported that dentists tend to view esthetics from the perspective of ‘art reproducing nature’; and should concentrate their efforts to provide esthetic restorations with the understanding of the limitations of the situation,
materials and techniques available. Patients, on the other hand, are more concerned with the desire for return to normalcy and a global sense of acceptability. Both of these papers were based on the prosthetic requirements of adult and elderly populations. Dental esthetics in the adolescent population is investigated mainly through orthodontic research that concentrates on tooth position rather than tooth replacement (Albino et al., 1984). There are no studies that investigate the urgent desire of parents to have their children’s avulsed permanent incisors replanted in order to restore normalcy.

The costs of trauma management affect patients, parents, clinicians and health care institutions. Lindqvist and Brodin (1996) reported that the Swedish government, through hospital budgets, subsidizes much emergency and rehabilitation treatment. Saywell et al. (1992) reported that in an urban American hospital, 36 per cent of emergency department billings were written off as bad debt every 6 months. The private insurance status of individual patients positively affected reimbursement and collections in these hospitals. Hamilton et al. (1997b) stated that in the UK, the major barrier to dental trauma care in the private sector was financial as 86 per cent of clinicians in private practice felt that the fees for trauma management were inadequate. Similarly, salaried public health dentists felt that time expended for trauma management was disruptive of other patient services (Hamilton et al., 1997b). Trauma management is, above all, disruptive to routine clinical practice. In North America, treatment is most often provided in private offices or clinics where professional fees are billed to parents or insurance plans on a fee-for-service basis. In most European countries, much of dental care is funded through hospital or public health clinics where economic studies concentrate on use of time and personnel resources. While the means of paying for
time/treatment appear different, clinical procedures and time requirements for replantation are remarkably consistent throughout Scandinavia, the UK and North America (Andreasen and Andreasen, 1994; AAE, 1995; Gregg and Boyd (RCSE), 1998).

**Economic studies**

The financial costs of medical trauma have been studied extensively but the costs of dental trauma have only recently been investigated (Solli et al., 1996; Glendor et al., 1998, 2000). Medical trauma costs are usually based on an incidence or prevalence approach and used to support preventive programs. Such studies report the total annual national (or regional) medical costs of trauma care rather than report costs per incident or individual.

Studies on medical trauma all develop a variety of different and complex cost formulae to support their study purposes. Malek et al. (1991) described the mean cost of emergency treatment for a variety of medical injuries. The injury incidence data (three-year period) from a Massachusetts injury prevention project was combined with a nationwide claims insurance data set. The authors estimated the mean cost of emergency care for various intentional and unintentional injuries according to the *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9 CM)*. The mean cost reported was not an absolute measurement of individual cost of care but was an extrapolation of the annual cost for emergency care of childhood injuries based on insurance claims. The 1995 Canadian Health Report used data from Statistics Canada’s 1993 General Social Survey (GSS) and compared them with the 1988 GSS (Millar, 1995). The 1993 GSS was based on a two-month computer-assisted telephone interview
of households with a target population of persons aged 15 and over. Although Millar’s study demonstrated an overall decline in accident rates and accident-related mortality rates, the impact of trauma remained high. Sixty-two per cent of accidents produced activity-loss days and almost one-third of all accidents led to financial loss. Out-of-pocket expenses for motor vehicle accidents (622 CAD) were almost 3 times that of sports accidents (249 CAD).

Medical trauma studies often attempt to quantify both direct and indirect costs. Lindqvist and Brodin’s 1996 study reported on the socioeconomic (indirect and direct) costs of accidents over a one-year period in Sweden. They described direct health care costs but also the cost to society of lost productive working time (including loss due to restricted activities). A prospective American study of trauma patients aged 16 to 45 years old (MacKenzie et al., 1988) reported average one-year treatment charges per case for different degrees of severity using the Abbreviated Injury Scale (AIS). Baraff et al. (1991) determined costs derived from assigning value to provider time by a formula that used annual income/salary, fringe benefits, productivity and direct care costs. This prospective study (data collection in 1984) developed a diagnosis-based, case-mix classification system for emergency department patient visits based on direct costs of care. The purpose of developing this system was to identify patients or groups of patients whose actual costs exceed the mean cost.

The variety of formulae used and currencies reported in these studies illustrate that there are problems comparing international socioeconomic studies of trauma management. Authors of many studies choose to convert their cost analyses into American dollars (USD) (de Loës, 1990; Olkkonen et al., 1993, Lindqvist and Brodin,
1996). De Loes’ study parameters included: type of injury, emergency room visits, number of follow-up visits, specialist visits, radiographs, physiotherapy, ambulance and in-hospital stays. De Loes (1990) noted difficulties when comparing medical treatment in different cities as patients were treated at different levels and there were variances in cost per level. Olkkonen et al. (1993) reported the social and medical consequences of bicycle accidents in Finland based upon patient records and telephone interviews. The social consequences involved functional disabilities (difficulty in cycling, walking, dressing and performing daily activities) and the concept that family members may be indirectly affected by the patient’s injuries. Health and social services costs included outpatient department visits, hospital inpatient time, physician visits, nurse visits, physiotherapy, radiographs, home-aid, family member trips and family member days absent from work. The authors stated that a generally accepted global system to measure the long-term consequences of non-fatal injuries did not exist. Lindqvist and Brodin (1996) investigated industrial costs such as employing replacement workers, loss of production and the direct costs of in- and out-patient care. They emphasized the problems of assigning costs to non-market issues. For instance, the authors chose to treat the time of all persons as equal value. They felt that there was no scientific evidence that a person’s income should reflect the value of his/her time. This assumption is more political than scientific.

Relative cost is another means of cost comparison. In 1986, *The Economist* devised the ‘Big Mac Currency’. *The Economist* updates the Big Mac Index annually as a guide to whether currencies are at a ‘correct’ level. ‘Burgernomics’ is based on the theory of purchasing-power parity (PPP). Comparing PPP with actual exchange rates provides an indication of whether a currency is under- or over-valued. The exchange rate of two
currencies should move towards the rate that would equalize the prices of identical goods and services. Big Mac PPP is the exchange rate that would leave hamburgers costing the same in the United States as abroad. For example, based on the April 2000 exchange rate, the cheapest Big Macs were in Malaysia ($1.19) and the most expensive were in Israel ($3.58). Given that in the United States, the average price of a Big Mac was $2.51, this implies that the Malaysian ringgit is the most undervalued currency (by 53 per cent) and the Israeli shekel the most overvalued (by 43 per cent). PPP could potentially be used to compare international health care costs to determine if health care is over- or under-valued. The disadvantage of this theory is that PPP relates only to traded goods; the Big Mac is not shipped across borders, and rents vary enormously across countries. Local prices may also be distorted by taxes, trade barriers and local competition so even this method is marginally applicable to health care economics. An alternative might be to determine a relative cost unit more applicable to different aspects of health care.

For instance, one-surface amalgam restorations might be considered the Big Mac of dental economics. It can be reasonably assumed that one-surface amalgam restorations are treated the same way in many countries and there would be no difference in type of material used. Based on the 1995 National Health Service (NHS) Statement of Dental Remuneration, Mjör et al., (1997) assigned the cost of a one-surface amalgam restoration as one unit and compared it with other types of ‘small’ restorations. NHS fees were computed by taking into account the time it takes to perform the treatment and the expenses involved (materials, equipment, practice and laboratory expenses). However, the authors also assigned 1.0 unit to a 3-surface amalgam restoration and compared it with different types of ‘large’ restorations. This assumption is contrary to all North
American fee structures for amalgam restorations where the number of surfaces reflects differences in both time and cost. The authors stated that this allowed comparisons of fees on a relative basis between different fee systems, countries and currencies. They noted that fees for restorations in the United States (US) were 3 to 4 times higher than the United Kingdom (UK). If PPP were to be applied, then depending on the reference point (i.e., the US or the UK), this might suggest that restorations in the UK were undervalued or alternatively, restorations in the US were overvalued.

The American study of Levering and Messer (1985) also assigned a cost unit of 1.0 to placement of a one-surface amalgam and cost units of other restorative procedures were calculated proportionately. In 1983, the undergraduate fee for a one-surface amalgam was 9 USD (i.e., 1 relative cost unit = 9 USD) and cost units of other restorative procedures were calculated based on the same fee schedule. Cost ratios, instead of actual dollars allowed for a retrospective comparison of costs. This study made no attempt to compare cost ratios of undergraduate fees to determine if their cost units were comparable to local or national private practice fees but they appear to be significantly lower than the national averages at the time.

The dental cost studies that assigned cost units were not specific to the complexities of different dental procedures or market fee guides. Mjör et al. (1997) and Levering and Messer (1988) both assigned one cost unit to a one-surface amalgam restoration. However, there was no specification of the tooth type (premolar, molar, primary tooth) or if responsibility or time (Levering and Messer, 1988) were accounted for in the assignment of one cost unit.
In Canada, The Ontario Dental Association (ODA) annually updates The ODA 
Suggested Fee Guide for General Practitioners. Their Fee Guide is based on a Relative 
Value Formula (RVU).

\[
\text{Fee} = (T \times R) \times F = \text{RVU} \times F
\]

Where \( T \) is the time required to perform the procedure (measurable in 15 minute units) 
and \( R \) is the responsibility factor that reflects the difficulty and risk of the procedures. 
Multiplying \( T \) and \( R \) produces the number of relative value units (RVU’s) for the 
procedure. \( F \) is a factor that converts the RVU’s to CAD. \( F \) is composed of \( P \), the 
professional income component and \( C \), the overhead costs. This system is supply-driven 
and designed for the private practice of general dentistry in Ontario, Canada.

Time is another resource that can be valued. Edward et al. (1990) estimated the 
time employed for trauma management was only 17 minutes and accounted for only 2 per 
cent of total time spent for dental care. Treatment time was based on actual figures 
specified in records or in cases where the specifications were missing, time was estimated 
based on routine appointment booking times for different procedures. This study focused 
on caries prevalence and the type of traumatic injury was not specified nor was there any 
differentiation between primary and permanent tooth trauma. The low time expenditure 
reported for trauma management can be explained since 30-50 per cent of trauma to the 
permanent dentition during regular office hours is uncomplicated crown fractures and in 
the primary dentition it is concussion and subluxation (Oikarinen and Kassila, 1987; 
Glendor et al., 1996; Hamilton et al., 1997a). These studies were all purpose-driven and 
other than the prevalence or incidence reports, these studies could not be duplicated nor 
were there any indication that the results were converging to a norm.
Two studies by Glendor and colleagues investigated the time spent on dental trauma management. The 1998 retrospective study included individuals born in 1970 that had sustained a dental injury and had complete dental records until 18 years of age. This study reported the number of dental visits and time utilized. The public dental system in Copenhagen allowed for continuous registration of all dental visits up to 18 years of age. The majority of injured patients (91 per cent) were treated by the public health services. The remaining 9 per cent were initially treated at hospitals, emergency services or private dentists and then referred to the public health services after emergency treatment. Treatment time (in five minute intervals) was calculated by surveying dentists to estimate normal treatment time (Glendor, 1998 – personal communication). The majority of time required for trauma management occurred within the first year. Complicated trauma was defined as dental fracture (crown/root fracture or root fracture) with pulp exposure and luxation injuries with dislocation. There were 5.3 visits per complicated trauma episode in the first year. There were 7.3 total visits per complicated trauma episode. The average treatment time per individual for permanent teeth was 8.5 hours for complicated injuries. The time calculation included history-taking, examination, registering the trauma with the insurance company, referrals by telephone and written and actual treatment. Complicated permanent tooth trauma demonstrated the largest variability and required the greatest number of visits. Complicated permanent tooth trauma is relatively infrequent (20 per cent), however, it accounted for 40 per cent of total treatment time for permanent teeth. The authors suggested that treating injured teeth in combination with other dental care could reduce total travel and waiting time. However, this was reported as seldom achievable in the treatment of complicated permanent tooth trauma. Variables not
addressed in this study were patient behavior or immature roots that would require prolonged treatment for apexification. Both of these variables would increase the time required for the treatment of young children following replantation.

The prospective study by Glendor et al. (2000) investigated the total direct (dentist) and indirect (people other than clinicians) time used for treatment and care of dental trauma in children and adolescents. Data were derived from insurance claims, trauma records and telephone interviews with patients or their parents. The first of four-part telephone interviews was carried out 2-4 months after the injury therefore memory recall was likely reliable. The two-year study period had a high retention rate (96 per cent, 192/200 patients and parents). Direct clinical time for all visits that pertained to permanent tooth trauma was a mean of 2.6 hours. This accounted for 33 per cent of total patient time and was consistent with their earlier retrospective study. Mean total time spent by the patients and their companions for complicated permanent tooth trauma was 13.9 hours and 8.5 hours respectively. Transportation consumed the most indirect time (30 per cent of total). The emergency visit required 5.2 hours or a third of total time of both patient and companions. As expected, complicated trauma required the greatest number of visits. There is great variability in the types of complicated permanent tooth trauma that were combined in the studies by Glendor et al. (1998, 2000). A more specific analysis of time required for individual trauma diagnoses (e.g. avulsions, intrusions, extrusions, etc.) would assist parents to understand the significance of these specific injuries.

Since avulsion injuries are rare, calculating the costs of this injury is made more difficult by sample size constraints. Solli et al. (1996) calculated the costs of 3 avulsion
injuries over a one-year period. Treatment time averaged 110 minutes. Unfortunately, there was no indication if these were new avulsion injuries or included ongoing treatment of old (>1 year) replantations. Due to the limited number of avulsion cases and the fact that the majority of trauma treatment occurs within the first year of the injury (Glendor et al., 1998), this study may not provide an accurate account of the clinical time requirements for replantation.

Long-term management

Management of avulsion injuries in children appears to be most labor intensive during the first year post-injury (Glendor et al., 1998). By the second year most treatment is completed and a period of observation ensues. Due to alveolar growth, some treatment options need to be delayed until skeletal maturity is achieved in young adulthood (Tripodakis et al., 1991; Steiner, 1997; Thilander et al., 1999). The survival of incisors is highly related to root maturity at the time of replantation (Andreasen et al., 1995a-d; Barrett and Kenny, 1997a). With time, infraocclusion becomes more evident due to subsequent alveolar growth (Ebeleseder et al., 1998; Kawanami et al., 1999).

Replacement of provisional restorations occurs more frequently in young children than in adults (Qvist et al., 1986). Robertson et al. (1997a) reported that composite restorations placed during school age (7-15 years) often have to be renewed at least once before 16 years of age. In addition, gingival recession is common around crowns following growth and may require surgical revision to restore normal soft tissue contours (Goodacre, 1990). Despite the guarded prognosis for replantation and information that incisors ultimately fail, parents continue to request/demand replantation at the emergency visit. Patients and
parents may feel the outcome is acceptable if the replanted incisor survives until the patient reaches skeletal maturity [15 to 21 years] (Tanner, 1962), at which time definitive prosthetic replacement can be provided. Late facial growth can produce continued tooth eruption into the third and fourth decades of life (Forsberg et al., 1991; Iseri and Solow, 1996). Therefore if implants are placed before adulthood, revision or replacement of prosthetic implants will be required to compensate for the lack of eruption in early-placed implants. The clinician’s role is to provide information on prognosis, rehabilitation expectations and estimated costs so that patients and their families will be able to make informed treatment decisions.
Statement of the Problem

Avulsion injuries of maxillary permanent incisors are rare but devastating injuries to children and adolescents since most teeth with delayed (greater than 5 minutes) replantation ultimately fail (Barrett and Kenny, 1997a). Parents often request/demand that incisors be replanted at the time of emergency treatment, despite being told of the guarded prognosis for survival.

Many of the social and financial costs of avulsion injuries borne by children/adolescents and their families have not been quantified or documented. Nevertheless, parents need information on the direct and indirect costs of replantation as well as their responsibilities in order to make informed decisions regarding the replantation of permanent incisors. In addition, an international system to compare the professional fee/time component of dental trauma would be valuable for comparison of trauma costs.

Purpose:

1. To retrospectively review management of avulsion injuries to permanent maxillary incisors of children and adolescents in a teaching hospital and in private practice environments in order to determine the social and financial costs of these injuries from first-aid management through follow-up/treatment including extraction.

2. To identify a common ground for coding treatment of avulsion injuries to permanent maxillary incisors such that the direct treatment ‘costs’ may be compared in North America, the UK and Scandinavia.
3. To determine a number of qualitative factors associated with avulsion injuries as follows:

**Primary objective:**
To determine if patients and parents would have chosen the replantation option if they knew the subsequent socioeconomic and treatment burden.

**Secondary objectives:**
To determine:

a) how much are families willing to spend to save/replace one anterior tooth.

b) what was the most important aspect of first aid management for the parent.

c) how much school and work time was missed due to the injury (both patient and parents).

d) how satisfied are the patients and parents with the function and esthetics of the replanted tooth or its replacement.

e) what were the patients’ and parents’ short and long-term expectations.

**Objectives:**

1. To review a series of replantation cases to identify the social and economic costs of dental avulsion injuries of permanent maxillary incisors using data from dental records. To interview patients and parents to determine their opinions about the accident and its sequelae.

2. To find a common ground for coding the clinical financial burden of management of avulsions.
3. To assist treatment planning and the informed consent process for avulsion injuries by providing information on costs, responsibilities and outcomes of replantation.
Methods and Materials

Subjects

Subjects were drawn from a larger sample of patients who attended the Department of Dentistry at The Hospital for Sick Children (HSC) for treatment of permanent dental injuries between June 30, 1988 and December 31, 1999 (Barrett, 1995; Lee, 1996; Humphrey, 1999). Protocol-based clinical management (according to 1983 AAE guidelines) for dental trauma was introduced at HSC in June 1988. Emergency and follow-up dental treatment was performed by dental residents and/or attending pediatric dentists. Records of all avulsion injuries in the Dental Trauma Research Unit were reviewed.

The inclusion criterion for the study was avulsed permanent maxillary incisor(s) that was/were replanted. For homogeneity of the sample, patients who were medically compromised and/or developmentally delayed were excluded in the study sample since due to their condition(s) it was difficult to adhere to HSC trauma protocol and AAE guidelines (e.g., poor compliance, general anesthesia required for treatment, less frequent recalls). Charts of all patients who met the inclusion criterion and had complete dental records for at least one year were reviewed.

In the case of individuals who had multiple incisor replantations and one incisor was subsequently extracted, treatment burden was calculated up to the time of extraction of the first incisor and included initial prosthetic replacement (worst-case scenario). Second stage care (orthodontics, fixed prosthodontics, implantology) is beyond the scope of this study.
Patient and Parental Consent

Patients that fulfilled the inclusion criterion were contacted by mail to request consent for release of records from their family dentist. Consent was also requested from both parent(s) and patients to participate in a telephone interview. The consent package was based upon Woodward and Chambers recommendations (1983) and included a cover letter (Appendix I), participant information sheet (Appendix II), and authorization for release of information (Appendix III).

For those patients whose consent packages were returned labeled as address unknown, the last recorded family physician and dentist were contacted to request the patient’s forwarding address. Internet searches were also performed to obtain the patient’s new address. One month after the consent package was sent out, the author (PMN) attempted to contact by telephone individuals who had not returned a consent form. A duplicate consent package was sent to patients who requested it and to patients who could not be contacted by telephone and had not returned the initial consent package.

Once consent was obtained, a signed release was faxed or mailed to the patient’s dentist(s) for a copy of their dental records from the period immediately after the avulsion injury to the time of this study (Appendix IV). Private practice records were labeled and incorporated into patient records in The Dental Trauma Research Unit.

Sample eligibility

The eligible sample was based on all patients that met the inclusion criterion (replanted maxillary incisors in non-medically compromised patients). Information was
recorded according to HSC protocol during the emergency treatment. Collection of data for the eligible sample was as follows.

Etiology of avulsion:

1. month and season when injury occurred
2. activity when avulsion occurred (e.g. baseball, bicycling, swimming, etc.)
3. location where avulsion occurred (school, home, playground)
4. extra-alveolar duration and storage conditions

Patient characteristics:

1. gender
2. age at time of avulsion
3. age at time of extraction of replanted incisor
4. dental insurance status

Avulsed incisor characteristics:

1. number of permanent incisors avulsed
2. stage of root development of avulsed incisor(s)

**Chart Review**

Chart review included the emergency and follow-up treatment burden of cases with complete records for one year or more. In cases of failed reimplantations, treatment was followed up to extraction and initial prosthetic replacement. Typical emergency treatments for replantation of avulsed incisors are:

1. emergency examination
2. radiographs
3. replantation and splint placement

Typical follow-up treatment include:

1. re-assessment examination
2. radiographs
3. pulpectomy
4. apexification
5. intracanal medicament placement
6. restoration
7. specialty consultation
8. extraction
9. interim partial denture

Data collection also included dental visits that involved routine care and care of other traumatized teeth:

1. treatment of concurrent traumatized teeth (but not avulsed teeth)
2. number of visits for non-trauma treatment
3. number of recall/hygiene appointments
4. number of missed or tardy appointments

The number of dental visits and the treatment provided were collected and combined with cost and time allotments derived from The Ontario Dental Association (ODA) Suggested Fee Guide for General Practitioners, 2000 (Appendix VI).

Data were collected for patients with records of at least one-year duration and for patients who had the replanted incisor extracted (worst-case scenario) (Appendix VI).
Time and costs based on 2000 *ODA Fee Guide for General Practitioners* were assigned to the collected data.

**Survey Development**

Telephone surveys were designed to determine patient and parental short-term and long-term expectations following replantation of avulsed incisors. Two surveys were developed, one for the parent of (30 minutes duration, Appendix VII) and a shorter one for the patient (15 minutes duration, Appendix VIII) (Dillman, 1978). Questions pertaining to the psychosocial and functional effects of the injury and treatment were also included.

The patient (Appendix VIII) and parent (Appendix VII) surveys included questions about demographics, etiology, functional variables, personal variables, social variables, information provided by the dentist, esthetic evaluation, and subjective variables. Questions modified from Robertson and Norén (1997b) for the present survey include those on biting function, dental fear, school and work time missed, anxiety regarding losing/breaking denture, colour/form of traumatized tooth, information provided regarding prognosis, and affects on social life. The format of the surveys was yes/no, multiple choice and short answer of both open- and closed-ended format (Dillman, 1978; Streiner and Norman, 1995). Scaled responses were based on the Likert scale with 7 categories (Streiner and Norman, 1995).

An announcement letter (Appendix V) was mailed to patients and parents who consented to participate in the survey (Dillman, 1978, Weisberg *et al.*, 1996). The letter informed them that the author (PMN) would contact them to conduct the interview in the
The letter also informed them that they would each be monetarily compensated (20 CAD for each completed survey) for their inconvenience (monetary compensation was recommended by Dillman, 1978).

One individual (PMN) conducted all interviews. Structured scripts were followed so that all interviews were consistent. To test content, comprehension and flow of the surveys, two pairs of trial interviews (Dillman, 1978, Woodward and Chambers, 1983) were conducted with parents (Appendix VII) and patients (Appendix VIII) who had been treated for their avulsion injuries in private offices (not part of the study population). Interviewees were encouraged to reschedule the survey if the time of the original telephone call was inconvenient. Answers were entered directly into the computer verbatim (Streiner and Norman, 1995).

**Statistical Methods**

All data were organized in a spreadsheet program (Microsoft® Excel 2000, Microsoft Corporation, Washington, USA) for analysis. The mean and age range, gender proportions and extra-alveolar duration for the available sample/subsample and unavailable sample were calculated. Student's t-tests and Fisher's exact tests were used to determine if there were significant differences between the chart review sample and the unavailable sample and between survey participants and the unavailable sample. McNemar’s tests were used for comparison between patient and parent responses. A critical $p$-value of 0.05 was used for all statistical tests in the study. All data were analyzed using SAS (SAS Institute, North Carolina, USA) and PASS (NCSS Statistical Software, Utah, USA) statistical programs.
Some patients experienced multiple avulsions therefore extra-alveolar storage and duration of these incisors was not independent. In these cases, only one incisor was considered when calculating means for each patient.

Hypothesis testing (McNemar’s test, critical $p = 0.05$) to compare patient and parental responses was performed on the primary objective of the survey (op cit.). Hypothesis generation with correction for multiple testing using an adjusted critical $p = 0.025$ was performed on secondary objectives (op cit.).
Results

Study population

Records of all avulsion injuries in the Dental Trauma Research Unit between 1988 and 1999 (n = 87) were reviewed. Figure 2 demonstrates the breakdown of the study population into 3 samples: eligible, chart review and survey.

*Number of patients (number of avulsed incisors)

Fig. 2: Distribution of sample population

During the period of 1988 to 1999, 87 patients presented with avulsion injuries to HSC dental clinic. Eighty patients met the inclusion criterion and had the avulsed incisors replanted. Complete records for one year were available for 43 patients.

Several attempts were made to contact all 80 patients for recruitment into the survey. Twenty-one patients and parents returned consents to participate in the survey.
Thirty patients could not be contacted (22 were confirmed as moved and 8 had incorrect phone numbers). Six patients indicated that they were not interested in participating in the survey when contacted by telephone. Attempts to recruit (both by telephone and mail) the remaining 23 patients were unsuccessful after 4 months. This resulted in 59 non-participants including the patients with incomplete records. The response rate was 26 per cent (21/80). However, if the response rate were calculated excluding unreachable patients (Dillman, 1978), the response rate of this study would increase to 42 per cent (21/50).

Eligible sample

Eighty patients (57 males: 23 females with 99 avulsed and replanted maxillary permanent incisors) met the inclusion criterion for the eligible sample.

The etiology of individuals sustaining avulsions was grouped according to activity. Sixty-five per cent of the injuries were the result of sporting activity. Bicycling was the most common activity (29 per cent), followed by baseball (17 per cent) and hockey (4 per cent). Other activities that caused avulsions included basketball, soccer, swimming, skateboarding and skating. Eleven per cent of avulsions occurred during school hours and almost half of the avulsions occurred during weekends and holidays (39 patients). The majority of avulsions occurred during the spring and summer months (Table 4).

Table 4: Occurrence of individuals sustaining avulsions by month

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
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</tbody>
</table>
The mean age at avulsion was 10.6 years (SD = 2.7; range = 6.6–17.7). The ratio of immature to mature root apices was 31:68. The majority of patients (79 per cent) had one avulsed incisor (Table 5). The mean extra-alveolar duration was 100 minutes (SD = 76.6; range = 0–420). Patients with multiple avulsions (Table 5) were counted only once in calculating mean extra-alveolar duration since each avulsed incisor was not an independent occurrence. Two-thirds of avulsed incisors were replanted with extra-alveolar duration in excess of one hour but only 11 per cent (11/99) of incisors were replanted within 15 minutes (Table 6).

None of the patients presented to either private or public health dental clinics before arrival at HSC. Thirty-five per cent of the patients initially presented to a community hospital and were subsequently referred to HSC for treatment. Incisors were replanted at the community hospital before referral in 11 cases. With few exceptions, upon presentation at HSC, the triage nurses placed avulsed incisors in milk while awaiting the dentist-on-call. Storage conditions were not reported for 5 patients; the incisor was placed in water for one patient; and in 2 cases, the triage nurse replanted the incisor.

Table 5: Number of avulsed incisors per patient

<table>
<thead>
<tr>
<th># Avulsions</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td># Patients</td>
<td>63</td>
</tr>
<tr>
<td>% Patients</td>
<td>78.8</td>
</tr>
</tbody>
</table>

Table 6: Number of teeth replanted by extra-alveolar duration

<table>
<thead>
<tr>
<th># Teeth</th>
<th>Extra-alveolar duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;5 minutes</td>
</tr>
<tr>
<td>99</td>
<td>5</td>
</tr>
<tr>
<td>80*</td>
<td>5</td>
</tr>
</tbody>
</table>

* Only one avulsed incisor was counted for patients who had multiple avulsions.
The insurance status of all patients was recorded at the time of emergency treatment. Fifty-three patients had private insurance coverage. Twenty-four patients reported no insurance coverage. Four patients were covered by social assistance.

Chart Review Sample

Complete records for a minimum of one year were obtained for 43 patients (29 males, 14 females) with 60 avulsed incisors. The available and unavailable samples (op cit.) are compared in Table 7. There were no significant differences between the sample population and the unavailable population.

<table>
<thead>
<tr>
<th>Table 7: Comparison of available and unavailable sample for chart review</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Demographic information</strong></td>
</tr>
<tr>
<td># patients</td>
</tr>
<tr>
<td>Ratio (M: F)</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>mean</td>
</tr>
<tr>
<td>range</td>
</tr>
<tr>
<td>sd</td>
</tr>
<tr>
<td>Extra-alveolar duration (min)</td>
</tr>
<tr>
<td>mean</td>
</tr>
<tr>
<td>range</td>
</tr>
<tr>
<td>sd</td>
</tr>
</tbody>
</table>

†Fisher's exact test; ‡Student's t-test; *Critical p = 0.05

The chart review sample was investigated for root maturity and time to extraction. The ratio of immature to mature apices was 23 to 37. Mean time to extraction was 2.2 years (range = 0.1-5.7 years). Mean age at time of extraction was 11.8 years (range = 7.2-19.1 years).

The majority of treatment occurred the first year following injury. During the first year, the mean number and type of dental visits were 1.2 emergency examinations and 4.8 reassessment examinations. Mean treatment procedures provided in the first year
included 5.5 diagnostic periapical radiographs, 1.9 occlusal radiographs, 1.3 pulpectomies, and 2.7 intracanal medicament applications. Pulpectomies were performed on 93 per cent (56/60) of the replanted teeth. Within the first year conventional gutta percha obturation was completed for 30 per cent (18/60) of replanted incisors. Thirty-three per cent of the patients required additional specialty consultations (other than pediatric dentistry) in the first year. Sixty-four per cent of the consultations were to see an oral and maxillofacial surgeon. Eighteen per cent (11/60 incisors) were extracted from 7 patients in the first year.

Patients with short duration replantations (worst-case scenario) were generally younger at the time of injury than patients with retained replantations (9.6 years and 10.8 years respectively) however the difference was not significant ($p = 0.145$). Over time, 23 patients had 31 incisors extracted. Mean number and type of dental visits in extraction cases included 1.4 emergency examinations, 6.2 re-assessment examinations and 1.4 specialty consultations. The radiographic burden included 6.6 diagnostic periapical and 2.9 occlusal radiographs. Six patients (8 incisors) had conventional endodontic treatment with gutta percha obturation. Following extraction 21 patients received interim partial dentures and two patients received Maryland-type bridges. The number of visits, avulsion/replantation treatment time and theoretical treatment cost were calculated (Table 8). The mean number of dental visits per individual in the first year including the emergency visit was 9.1 (SD = 2.6; range = 4-15). The majority (96 per cent) of the visits (mean = 8.8; SD = 2.4; range = 4-15) were related to trauma management. Based upon time values of the ODA Suggested Fee Guide, mean treatment time per individual for trauma was estimated to be 434 minutes (7.2 hours) in the first year. Utilizing 2000 general practitioner fees, the theoretical mean cost of
management in the first year would be 1465 CAD. Similarly, the theoretical mean cost for
the worst-case scenario (up to insertion of interim prosthetic replacement) would be 1781
CAD (SD = 563; range = 924-2529).

Table 8: First-year estimated direct treatment time and cost for management of
avulsion/replantation

<table>
<thead>
<tr>
<th></th>
<th>Number of visits</th>
<th>Time (min)†</th>
<th>Cost (CAD)†</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean (x̄)</td>
<td>8.8</td>
<td>434</td>
<td>1465</td>
</tr>
<tr>
<td>sd</td>
<td>2.4</td>
<td>151</td>
<td>459</td>
</tr>
<tr>
<td>range</td>
<td>4-15</td>
<td>120-840</td>
<td>458-2531</td>
</tr>
</tbody>
</table>

†ODA Suggested Fee Guide 2000

First year treatment cost and direct time were compared between patients who had
their incisor(s) extracted with those who retained them. Treatment costs were significantly
higher (Student’s t-test \( p = 0.03 \)) in the first year for the extraction sample than those with
retained incisors (Table 9). There was no significant difference in direct treatment time
between the extraction sample and those with retained incisors \( (p = 0.11) \). Figure 3
demonstrates the comparison of first year direct treatment time between extraction and
retained samples (Appendix IX). Figure 4 demonstrates the comparison of first year
treatment cost between extraction and retained samples (Appendix X).

Table 9: Comparison of estimated first-year direct treatment time and cost between
retained and extracted samples

<table>
<thead>
<tr>
<th></th>
<th>Retained</th>
<th>Extracted</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>36</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Cost (CAD)</td>
<td>x̄</td>
<td>1403</td>
<td>1781</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>418</td>
<td>563</td>
</tr>
<tr>
<td></td>
<td>range</td>
<td>458-2530</td>
<td>924-2529</td>
</tr>
<tr>
<td>Time (min)</td>
<td>x̄</td>
<td>421</td>
<td>504</td>
</tr>
<tr>
<td></td>
<td>sd</td>
<td>141</td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>range</td>
<td>120-840</td>
<td>180-735</td>
</tr>
</tbody>
</table>

*Critical \( p = 0.05 \)
Survey Sample

Consent to participate in the survey was obtained from 21 pairs of patients (14 males, 7 females) and parents (3 fathers, 18 mothers). Participants and unavailable sample (see Fig. 2: 37 patients with incomplete records and 22 non-participants) were compared according to mean ages and mean extra-alveolar duration and gender proportions (Table 10). There was no significant difference between the two groups in
extra-alveolar duration or gender proportions. The mean age of patients who participated in the study (9.5 years) was significantly less than the non-participants (11.0 years) ($p = 0.027$). Of the 43 patients with complete records, 23 patients had the replanted incisor extracted. No statistical difference in extraction age was demonstrated between survey participants and non-participants (worst-case scenario) ($p = 0.273$) or survival time ($p = 0.931$).

Table 10: Comparison of available and unavailable sample for survey analysis

<table>
<thead>
<tr>
<th>Demographic information</th>
<th>Available sample</th>
<th>Unavailable sample</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td># patients</td>
<td>21</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Ratio (M: F)</td>
<td>2: 1</td>
<td>43: 16</td>
<td>0.780</td>
</tr>
<tr>
<td>Age (years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>9.5</td>
<td>11.0</td>
<td>0.027*</td>
</tr>
<tr>
<td>range</td>
<td>6.9-15.1</td>
<td>6.6-17.7</td>
<td></td>
</tr>
<tr>
<td>sd</td>
<td>2.1</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Extra-alveolar duration (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\bar{x}$</td>
<td>93.0</td>
<td>102.8</td>
<td>0.602</td>
</tr>
<tr>
<td>range</td>
<td>3-225</td>
<td>0-420</td>
<td></td>
</tr>
<tr>
<td>sd</td>
<td>64.8</td>
<td>76.8</td>
<td></td>
</tr>
</tbody>
</table>

†Fisher’s exact test; ‡Student’s t-test, *Critical $p = 0.05$

Responses to the surveys were analyzed with respect to primary and secondary objectives.

Primary Objective

The primary objective was based upon informed consent and parental decision-making. Patients and parents were asked, ‘if you knew what you know now, would you prefer to have the incisor replanted or left out?’ A majority of patients’ and parents’ responses indicated that they would still elect to have the incisor replanted [67 per cent (14/21) and 81 per cent (17/21) respectively]. Patient and parental responses showed no significant difference (McNemar’s test, $p = 0.453$). This decision was consistent even in
cases where the incisor was subsequently extracted (Fisher’s exact test, \( p = 0.638 \) and \( p = 0.827 \) respectively).

**Secondary objectives**

The secondary objectives were based on economic considerations, information and expectations, treatment outcomes, and esthetics. Patients were asked how much they were willing to spend to save one incisor. Almost half of the parents (48 per cent, 10/21) reported that they would be willing to pay over 2000 CAD. Parents’ perception of value and their insurance status did not demonstrate significant difference (\( p = 1.0 \)). Omitting the one patient who was covered by government assistance, an equal number of parents with and without insurance reported that they were willing to pay over 2000 CAD (8 parents each) and an equal number of parents said they would not pay over 2000 CAD (2 parents each).

Parents were asked whether they were informed at the emergency (E) and follow-up (F) appointments of:

1. how long the tooth would be in the mouth
2. potential for loss of the replanted tooth
3. long-term costs
4. number of appointments required
5. the need for root canal treatment.

A majority of parents reported that they were informed at both the emergency and follow-up appointments that long-term treatment would be costly and several appointments would be required (Table 11). The majority of parents reported that they
were not informed of the expected duration for incisor survival or potential for failure.

Just over half of the parents reported that they were not informed of the need for endodontic treatment.

**Table 11: Information given to parents at emergency (E) and follow-up appointments (F)**

<table>
<thead>
<tr>
<th>Information given</th>
<th>Yes (%)</th>
<th>Emergency</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival time</td>
<td>5.3</td>
<td>28.6</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>88.9</td>
<td>71.4</td>
<td></td>
</tr>
<tr>
<td>Endodontic treatment</td>
<td>47.4</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td># of Appointments</td>
<td>94.7</td>
<td>89.5</td>
<td></td>
</tr>
<tr>
<td>Potential for tooth loss</td>
<td>19.0</td>
<td>28.6</td>
<td></td>
</tr>
</tbody>
</table>

Another secondary objective was to determine what parents felt were the most important aspects of first-aid treatment. Parents were asked to rank the 3 most important aspects from 5 choices (Figs. 5, 6, 7):

1. trust in the dentist
2. prompt treatment
3. information regarding outcome of injured teeth
4. getting your child out of pain
5. replanting the tooth so that your child will still have a front tooth for school.

'Getting the child out of pain' was the most important aspect of first-aid treatment. The second most important aspect was 'prompt treatment'. The third most important aspect was 'replanting the incisor so that the child will still have a front tooth for school' (return to normalcy).
Fig. 5: Emergency treatment: Most important aspect
Parents, n=21

Fig. 6: Emergency treatment: Second most important aspect
Parents, n=21

Fig. 7: Emergency treatment: Third most important aspect.
Parents, n=21
Patients were asked to recall the events of the accident. Approximately half (10/21) of the patients reported significant bleeding at the time of the accident.

Patients and parents were asked to rate on a scale of 1 to 7 (no difficulty to very difficult) the degree of difficulty in biting with the replanted incisor soon after the accident compared to the present. At the time of the accident, patients and parents gave moderate ratings for the degree of difficulty in biting function (4.0 and 4.2 respectively). For patients who still had the replanted tooth in place at the time the survey was conducted, patients and parents both rated the degree of difficulty to be 1.8 (that is, little difficulty in function). Of patients who had the tooth extracted and were subsequently wearing a removable denture, patients and parents rated the degree of difficulty at 3.0 and 4.4 (both moderate ratings of difficulty) respectively. There was no statistical significance between patients’ and parents’ responses. For patients who still had their replanted incisor in place, parents’ perception of their child’s function was significantly different at the time of the survey compared with the time of the accident (i.e., 1.8 to 4.2 respectively, paired t-test, $p = 0.047$). However, due to multiple testing with a small sample, this was not significant at the corrected critical $p$-value of 0.025.

Patients and parents were asked to evaluate the esthetics of the replanted incisor or its prosthetic replacement on a scale of 1 to 7 (very dissatisfied to very satisfied). Patients and parents gave the colour of the replanted incisor neutral satisfaction ratings, that is, 4.1: 4.4 respectively. The colour of the denture received high satisfaction ratings of 6.1: 6.4. Patients rated the position of the replanted incisor to be neutral, 4.5 (parents were not asked this question). There was no significant difference between patient and parent ratings ($p = 0.746$ and $p = 0.443$ respectively).
Patients and parents were asked to rate treatment outcome acceptability (1-7 scale). Treatment outcomes were:

1. Retaining the replanted tooth through adolescence
2. Colour of the replanted tooth
3. Position of the replanted tooth.

Patients rated retention of the replanted incisor as significantly more important than infraocclusion (one-way ANOVA, $p = 0.01$; Tukey HSD). That is, patients would rather have an infraoccluded incisor than not have one at all. This was still significant with the corrected critical $p$-value for multiple testing.

School time and work time loss was reported by 90 percent of patients and 86 percent of parents. One-way travel to HSC ranged from 30 to 60 minutes. Twenty-nine percent of patients in the current study reported that the trauma affected other activities. Restrictions included discontinuing sports, restriction from recess or gym several months after the injury and self-consciousness of eating in a public environment. In addition, 57 percent (12/21) of patients reported that they stayed home from school for 1 to 2 weeks after the accident due to swelling, pain and difficulty eating.

Dental anxiety was not evident in this survey sample population. All patients denied having any dental fears. The patients who were wearing partial dentures worried about losing or breaking their denture. Patients preparing for extraction of the replanted incisor and/or implant surgery reported anxiety about the pending surgery.

Interim rehabilitation choice for all patients (who had the replanted incisor extracted) was a removable denture. Permanent rehabilitation was most commonly endosseous implants. At the time of the survey, 8/12 patients had or were preparing for
implants. Two additional patients expected to have their replanted incisor extracted and replaced with an implant. Therefore, implants were the permanent rehabilitation of choice for 10/21 patients. Fixed bridges were uncommon treatment choices as one patient had a full-coverage prosthesis and one patient had a resin-bonded bridge. Orthodontic treatment was required prior to rehabilitation for 7/21 patients. One patient planned to have the extraction space closed and the adjacent tooth recontoured.
Discussion

Avulsion injuries are rare but devastating injuries. When they occur in children and adolescents, the injury affects both patients and their parents. Behavior management, growth considerations, esthetics and social acceptance all influence treatment choices. In addition, financial concerns and time resources of the clinician, patient and parents must be considered.

Informed consent requires parents and patients to be informed of chances of survival, expected costs, direct and indirect time requirements and long-term rehabilitation choices. Clinical outcome studies (Andreasen et al., 1995a-d, Barrett and Kenny, 1997a) allow dentists to explain the prognosis and offer treatment choices to patients and parents. However, to date there are no studies that address the social and economic impact of avulsion injuries. Studies that report cost analysis (Solli, et al., 1996), type of treatment (Glendor et al., 1998) and (direct and indirect) time expenditure (Glendor et al., 2000) involve a range of dental injuries. This is the first study to investigate the socioeconomic consequences of avulsion injuries exclusively.

Sample

Most avulsions occur outside of regular dental office hours and the severity of the injury prompts parents, caregivers and patients to go directly to the hospital for emergency treatment rather than to their family dentist (half of the patients surveyed reported significant bleeding at the time of the accident). The 50 pediatric dentists who practice in Toronto and environs were contacted and asked if they had treated any avulsion injuries during the study period of 1988 to 1999. Approximately 10 per cent of
the specialists recalled treating one or two avulsions in this time frame. Over half of the answering machines of pediatric dental offices in the city (17/32) refer their patients to HSC for dental emergencies if the specialist cannot be reached.

The questions in this study were based upon Robertson and Norén’s (1997b) subjective categories of dental trauma. The response rate (26 per cent, 21/80) for participation in this survey was lower than the study by Robertson and Norén (66 per cent). The low response rate in the current study may be due to the requirement of two respondents (patient and parent) to participate in the survey (Shaul et al., 1999). Surveys were conducted by telephone as opposed to mail or personal interviews. Telephone interviews allowed for open-ended questions and encouraged patients and parents to tell their story (as opposed to mail surveys). It is also less intrusive and more convenient for patients and parents than personal interviews.

Although the mean age of survey participants (9.5 years) was significantly younger ($p = 0.027$) than the unavailable sample (11.0 years) there was no statistical difference in survival time or age at extraction. Therefore, it is unlikely that treatment outcome (survival/failure) affected patients’ and parents’ willingness to participate in the survey. The difference in age is of limited clinical significance as individual and sex differences in root maturity for maxillary central and lateral incisors approximate the 18-month difference between the two samples.

**Eligible sample**

None of the 80 patients who sustained avulsions went to a dental clinic prior to presenting at HSC. One-third of the patients presented to a community hospital prior to
referral to HSC. This is in contrast to the survey by Hamilton et al. (1997c) that reported that 60 per cent of lay people would refer a child with an avulsed tooth to a dentist as opposed to a hospital (11 per cent) or dental hospital (19 per cent). The current study is in agreement with the survey by Stokes et al. (1992), in that all 21 parents reported that HSC was either their first choice or they were referred by their family dentist, physician or another hospital.

The transit time (and emergency room waiting time, often at peripheral hospitals) to HSC increased the extra-alveolar duration of the incisors. However, Andreasen et al., (1995d) demonstrated that when the extra-alveolar duration is beyond 5 minutes, the chances of regeneration of periodontal ligament are very slight and it becomes less than half by 15 minutes. Replantation by triage nurses or emergency physicians was uncommon so replantation was usually delayed until the dentist-on-call arrived at the hospital. However this is a moot point since avulsed teeth with an extra-alveolar duration beyond 15 minutes will not demonstrate PL regeneration.

This study suggests that in the catchment area of this hospital, community dentists seldom treat avulsion injuries. Hamilton et al. (1997b) noted that the dentists surveyed felt that they were insufficiently compensated for the dental trauma treatment and also caused disruption of usual and customary treatment. In the greater Toronto area, the majority of avulsion injuries sustained by children and adolescents are treated at HSC, thus the hospital dental department bears the cost of a portion of the emergency treatment. Emergency treatment is always an unplanned visit. Re-assessment examinations and follow-up treatment are planned visits and do not cause practice disruptions. After hours emergency dental treatment after-hours often involves one
dentist working alone (no auxiliaries) and this prolongs treatment time. This appears to be overlooked in fee schedule time allotments (Appendix VI). According to *ODA Suggested Fee Guide*, the time for emergency examination was at most 30 minutes and replantation and splinting was allotted 30 minutes. Though the current study did not record the time of individual procedures, emergency appointments for avulsion injuries require at least 2 hours for one dentist working alone (from HSC emergency records and trauma information sheet of patient arrival and discharge time). The *Suggested Fee Guide* provides billing/identification codes for after-hour premiums and for additional time requirements but dental insurance companies seldom reimburse these codes. At HSC, these codes were never charged. This supports the contention that institutions often subsidize dental trauma treatment through clinician time and materials.

The fee formula in *The ODA Suggested Fee Guide* is currently being revised. The existing formula is supply-driven and designed for the private practice of general dentistry in the province of Ontario but does not acknowledge demand market conditions. Despite these limitations, the combination of time and descriptors provided (Appendix VI) is the best method for coding treatment for comparison. This method is adaptable to practices in North America, the United Kingdom and Scandinavia.

The cost of avulsion/replantation management in the first-year post-trauma was significantly higher \( (p = 0.03) \) for patients who had their incisors extracted than those with retained incisors however there was no significant difference in direct treatment time \( (p = 0.11) \). The cost difference reflects the difference in the additional procedures of a surgical extraction and insertion of a removable denture.
Primary objective

Despite the extensive treatment requirements and in some cases, subsequent extraction following replantation, the majority of patients (67 per cent) and parents (81 per cent) indicated they would still have replanted the avulsed incisor. Though there were a greater number of parents who were committed to the replantation decision than patients, the difference was not significant. It was determined that 138 patient and parent (matched pair) surveys would be required (McNemar sample size estimation $\alpha = 0.05; \beta = 0.2$; two tailed) to detect if there were differences in patient and parent responses. Due to the rarity of this injury it would require more than an additional ten years to obtain a sufficient sample to determine statistically if there was a difference in parent/patient responses. Alternatively, a prospective, protocol-based multi-center study would expedite data collection. It is clear that parents and/or adolescents will continue to request replantation at time of injury.

Parents commented on the importance of filling the space with a tooth even if for a short time and the importance of avoiding dentures at a young age. Patients and parents also commented that since having experienced replantation, they now know better how to manage avulsions (immediate replantation, appropriate storage medium, minimal extra-alveolar duration). Parents/patients who would not replant indicated their reasons as pain (replantation and surgical extraction), root canal therapy at a young age, poor esthetics following replantation, inevitable failure and the option to have an endosseous implant(s). Even though it was explained that implants are not recommended until skeletal maturity, two parents and one patient preferred to wait for an implant rather than replant the incisor at the time of the injury.
Secondary objectives

An endosseous implant and prosthetic replacement of one incisor costs over 2000 CAD and are often not covered by dental insurance. This value was chosen as a measure of parental perception of the value of one incisor. Fortunately, in Ontario, children without private insurance can obtain government assistance for emergency dental treatment and subsequent treatment will often be covered as well (with limits). Hence, insurance status at the emergency appointment is often of little importance despite coverage not being representative of the full value of time required. As insurance status (and co-payment levels) often change over time as does family income, it may be impossible to develop a co-relation between insurance status and willingness-to-pay over time.

A removable prosthesis is generally the treatment of choice to replace missing teeth in children and adolescents. One parent pointed out that private dental insurance only covers a new denture every 5 years. However, to accommodate growth, these patients often require a number of dentures throughout adolescence and this expense is often borne by the parents. Additionally, dentists bear some of the expense of treating trauma patients since they generally do not charge a professional fee (other than the laboratory fee) for repair of dentures that are less than one-year old even in cases of patient negligence.

Information given to parents during the emergency appointment appeared to be heavily skewed towards time and cost expectations with less information on prognosis. When the trauma protocol was implemented in 1988, prospective outcome studies had
not yet been published (Andreasen et al., 1995a-d; Barrett and Kenny, 1997a). Barrett and Kenny's study was the first to provide treatment outcomes specific to the pediatric/adolescent age group. Thus, in only the last 4 years of data collection in the current study (1995 to 1999) were survival data available. Parents reported that time and costs were vague with no actual values given. This is expected since there were no time/cost studies published (in the English literature) during the duration of the data collection. During the emergency appointment, 16/18 parents (3 were not present at the emergency appointment) reported that they were told treatment would be costly however they all noted that no dollar approximation was given. Eighteen of nineteen parents reported that they were told many follow-up appointments would be required. Almost all of the parents claimed that they were not told of the prognosis of replantation. This is higher than Robertson and Norén (1997b) who reported that 61 per cent of patients claimed they were not informed of prognosis of traumatized teeth. Parents reported (18/19) that they were never given a time frame for survival and 17/21 patients were not informed of the probability of extraction. Less than half of the parents reported that they were informed of the need for endodontic treatment. This was unexpected since endodontic treatment is part of the AAE guidelines. Not being informed of endodontic treatment may be due to the fact that some of the endodontic treatment was already performed during the first emergency treatment or during subsequent follow-up visits. While it is not surprising that parents were not fully informed of the prognosis of replantation, they could have been informed of the potential for failure. The majority (81 per cent) of parents requested or chose to have the incisor replanted even though they were informed that it would be costly with no guarantee of survival.
Robertson and Norén's (1997b) survey is the only study that investigated the subjective aspects of dental injuries based on the patient's perspective. They reported 21 per cent of patients indicated that several school hours were missed for appointments and 31 percent of parents had to take time off work. This is a much lower percentage than the HSC sample. School hours missed and time off work for 90 per cent of HSC patients and 86 per cent of HSC parents reported follow-up appointments respectively. Twenty-nine per cent of patients in the current study reported that the trauma affected other activities as compared to that of Robertson and Norén (9 per cent).

Although the majority of emergency treatment was after-hours, all follow-up treatment was during clinic hours. This explains why a high percentage of patients and parents reported time missed from school or work. The average age of all patients in the current study was 10.6 years at the time of the accident and the majority of dental treatment was in the first year. Consequently, missed school-hours mainly affected elementary school students. Five-year survival has been reported to be 65 per cent (Barrett and Kenny, 1997a) therefore by the time the patients entered high school, follow-up appointments were usually of short duration and scheduled before or after school.

Clinicians might assume that patients go back to school the day after the accident. In this study, 57 per cent (12/21) of patients reported that they stayed home from school for 1 to 2 weeks. However, the inability or reluctance to go back to school immediately may partially be due to other injuries involved and not specifically due to the replanted incisor (e.g. extra-oral lacerations, pain from concomitant injuries, etc.).

The majority of adolescents who had removable dentures commented that they were worried about losing or breaking them because they would be without the denture
for at least a day while it was repaired. All patients denied having any dental fear and ironically, many reported that the dental trauma likely contributed to their comfort with subsequent encounters with dentists. This contrasts with Robertson and Norén's (1997b) study that reported 28 per cent of patients reported dental fear and 43 per cent said it was due to the treatment effects of the accident. In the current study, the parents of two patients reported that the patient had dental fear however both patients denied it. Though proxy reporting has been shown to be reliable in studies of children particularly if a parent is proxy reporting for the child (Rajmil et al., 1999), bias increases with psychological conditions (Rothman et al., 1991). It is difficult to speculate on the nature of the disparity in patient and parent perception of dental fear since it was an incidental finding (parents were never asked a question on dental fear but two parents volunteered the information). Despite the severity of the injury, only 33 per cent of the patients reported that they often think about the injury compared with the 75 per cent reported in Robertson and Norén's (1997b) study. The study of Robertson and Norén included the full range of dental injuries whereas the current study deals exclusively with avulsions of permanent incisors.

Prosthetic replacement of extracted teeth in the HSC sample was different from the study by Robertson et al. (1997a). Their retrospective study included 22 avulsions among the range of injuries. After 15-year follow-up, 81 per cent (18/22) of the teeth were extracted (there was no mention whether all of the avulsed teeth had been replanted). Full coverage prosthesis was the prosthetic replacement of choice (12/18) followed by resin-bonded bridge (4/18). None of the patients had an implant or orthodontic treatment to close the space. There was no mention whether the two
remaining patients wore a removable denture or did not have any prosthetic replacement at all. By contrast, in the HSC survey sample 12/21 patients had the replanted incisor(s) extracted and in all cases, interim removable dentures were worn. Endosseous implants was the anticipated permanent rehabilitation of choice for 10/21 patients. The difference in rehabilitation choices between this study and that of Robertson et al. may be financial.

In Canada, most dental services and particularly prosthetic treatment is either privately funded by dental insurance and/or self-funded. However, in Scandinavia, dental services are publicly funded up to 19 years of age (Robertson et al., 1997a).

Since this study did not report a difference in insurance status and parents’ willingness-to-pay, it is difficult to speculate if the decision for dental implants was based on funding. The HSC dental clinic has a multidisciplinary approach and all dental specialties are represented. Patients and parents were told at the emergency and follow-up visits of the implant option and specialty consultations were coordinated. Since the majority of patients with failed or failing incisors planned to have an implant replacement, it is not surprising that a removable denture was the interim treatment of choice.

Although patients and parents understand that an implant may be the final outcome, they were often not aware of the process. This information was not available during the duration of the data collection for the current study since studies have not been published regarding implants placed in adolescents subsequent to trauma. Many incisors fail due to ankylosis and require surgical extraction that involves a mucogingival flap and bone removal. Some patients reported painful experiences, others reported anxiety about the pending extraction. Since incisors are usually extracted several years before implant
placement, bone grafts are often required prior to implant placement because of the loss of alveolar bone. At HSC, oral surgeons usually harvest bone from the iliac crest using a minimally invasive procedure that employs a trephine technique. Two patients (male) reported concern in anticipation of the bone graft, as they are both actively involved in sports. Orthodontic treatment may also be required for preliminary alignment prior to implant placement. Assessment of long-term rehabilitation is beyond the scope of this study.

Comparison with the study by Glendor et al. (1998) has value even though the samples are different. The current study consists of a homogeneous sample of avulsion/replantation whereas the study by Glendor et al. classified dental injuries as complicated and uncomplicated. Replantations were included in Glendor’s larger ‘complicated’ subsample. In the current study the total number of dental visits in the first year (9.1) approximates that reported by Glendor et al. (11.9). However, the HSC sample demonstrated an overwhelming number of the visits (96 per cent; 8.8 visits) involved direct trauma management in contrast to Glendor et al. (44.5 per cent; 5.3 visits). No attempt was made to compare the total number of visits per individual or trauma episode because Glendor et al. did not specify his end-point (i.e., extraction, final prosthetic replacement). Patients with failed replantations require treatment that is directly related to the trauma (prosthetics, orthodontics, oral surgery). Ongoing rehabilitation treatment is beyond the scope of this study.

Mean treatment time per individual for avulsion injuries was 434 minutes (7.2 hours) in the first year. This is a conservative estimate since radiographs were not assigned time units and were not included in the time estimate. This is 3.9 times higher
than the study by Solli et al. (1996) that reported 110 minutes of treatment time for avulsion injuries (n = 3). This current study's results are similar to the study of Glendor et al. (1998) who reported 1.7 hours for emergency treatment and 6.9 hours for planned visits. This amounts to a total of 8.6 hours of treatment time for complicated trauma per individual. As mentioned earlier, emergency treatment times in the current study were underestimated because one dentist working alone after-hours requires more time than that assigned in the *Suggested Fee Guide*. Treatment of concomitant injuries was not included in the time estimate as it would introduce too many treatment variables and compromise homogeneity of the sample. It is acknowledged, however, that patients with multiple injuries will require additional treatment time and costs beyond those estimated in this study.

The indirect (non-clinician) time of both patients and parents must be considered as well. Dental treatment in the hospital requires patients to register 15 to 30 minutes prior to the dental appointment and this increases waiting time beyond that expected in a private office. Transportation time is varied and one-way travel takes 30 to 60 minutes. Glendor et al. (1998) suggested that one way to reduce travel and waiting time would be to combine non-trauma-related treatment with trauma management. This was seldom possible in the current investigation. Patients were followed at HSC exclusively for trauma management and were referred to their family dentist for routine care. This suggests that patients followed at the hospital for trauma management required more total dental visits than those treated privately. However, the HSC patient population seldom required dental treatment other than routine hygiene recall visits. Follow-up examinations
for trauma were required more frequently than recall examinations and so visits could not be combined.

Dentists also spend indirect time on trauma management. Time spent on professional correspondence and phone calls to the patient’s family, insurance company, family dentist, and informal consults with other specialists (patient not present) were not tabulated. Missed appointments and last minute cancellations of 30 to 60 minute appointments were common in the HSC sample of children with replanted incisors.

It was not possible to calculate the costs per individual due to changes in the fee schedule over the eleven years of data collection. However, using the descriptor codes and applying it to the fee guide (Appendix VI), the theoretical cost can be estimated for any given year. Since the replantation treatment protocol had not changed over the 11 years of data collection the most current fee guide was applied so that current costs can be used to inform parents and patients. The mean first year cost was 1465 CAD and supports the choice of greater or less than 2000 CAD used in the secondary objective. This mean calculation can be used to inform parents approximate first year costs for management of replantations. Worst-case scenario costs are slightly higher (1781 CAD) which is expected since these cases have the additional cost of surgical extraction and interim prosthetic replacement. This cost does not include the cost of definitive restorations such as conventional bridges or endosseous implant and prosthetic fixture.

It is speculated that there are a number of trauma-related procedures and adjustments that are provided by dentists pro-bono. Not all reassessment examinations are billed, particularly when they are combined with other treatment such as splint removal. In a number of cases, it was noted that patients are often only billed the
laboratory fee for denture repairs despite the observation, assessment and adjustment time required. In addition, refreshment of intra-canal medicament was not always billed since it was considered part of ongoing endodontic treatment. Behavior management is always a time consideration when treating the pediatric population. Other than the fee differential between specialists and generalists, there were no additional charges for ‘exceptional’ patients or for ‘unusual time and responsibility’, two billing codes that might have been legitimately billed.

Treatment time and costs for avulsion/replantations are likely underestimated despite the fact that they are much higher in this study than previously reported (Edward et al., 1990; Solli et al., 1996; Glendor et al., 1998, 2000). This study provides a basis to calculate minimum first year direct treatment time and costs of avulsion injuries. Time appears to be the common resource to investigate trauma management costs. Using the codes, descriptors and time allotment (Appendix VI), the cost of avulsion injuries can be compared in the UK, Scandinavia and North America. Additional time and costs will be required for replacement of failed incisors.
Conclusion

Socioeconomic costs of avulsion injuries are quantifiable.

1. The desire to have incisors replanted is very strong even in experience patients and parents. Even after having gone through the painful experience of replantation, the demands of recall, and in some cases extraction, the majority of patients (67 per cent) and parents (81 per cent) stated they would have still made the same (replantation) decision. McNemar’s test failed to demonstrate a significant difference between patient and parent’s preference to replant. Sample size was the reason no statistical difference was observed.

2. Almost half (48 per cent) of the parents indicated that they would be willing to pay over 2000 CAD to maintain one incisor. There was insufficient evidence to conclude whether insurance status correlated with willingness-to-pay.

3. The majority of time required for treatment of avulsion injuries occurred in the first year. The most common procedures were emergency examination, replantation and splint placement, radiographs, follow-up examinations, pulpectomy, conventional root canal treatment, oral and maxillofacial surgery consultation, surgical extraction and interim partial denture fabrication. This is consistent with AAE Guidelines and Guidelines of the Royal College of Surgeons of England.
4. Replantation management accounted for 96 per cent of patients’ total dental visits in the first year. The number of trauma-related visits in the first year for avulsion injuries (8.8 visits) is greater than those for other complicated permanent tooth injuries (5.3 visits) as reported by Glendor et al., (1998).

5. Parents ranked the following (in order) to be of importance in obtaining emergency treatment:
   i. Pain relief
   ii. Prompt treatment
   iii. A return to normalcy

6. Time units and treatment descriptors were determined according to The ODA Suggested Fee Guide for typical and potential treatment involved in avulsion injuries (Appendix VI). The time and costs associated with management of avulsion injuries are underestimated in The Fee Guide. The present study suggests that patient, parent and practitioner indirect time and pro bono services provided by the dentist are often not considered.

7. Parents reported an improvement in patient function from immediately following the accident to the present.

8. Patients felt that immediate replantation of the incisor (normalcy) was more important than long-term effects of infraocclusion (esthetics) ($p = 0.01$).
9. Severe dental injuries such as avulsions present more often to the hospital dental clinic after-hours than to private clinics or offices. Training of dental residents in trauma management should include provision of information regarding treatment outcome, prognosis, time expectations and costs involved. Since the majority of patients and parents request replantation, long-term treatment options and expectations should be addressed during emergency treatment and reviewed at follow-up appointments.
References


Ontario Dental Association.(2000) *The ODA suggested fee guide for general practitioners.* Toronto, ON.


Appendix I

Cover Letter

HSC Letterhead

Date

Patient Name
Address

Dear Patient Name:

Our records show that when your front tooth was knocked out on accident date, you were treated at The Hospital for Sick Children.

Research is continually being carried out so that we can improve our treatment of these injuries. You play an important role towards reaching this goal. Enclosed is an information sheet to explain a little about our study. We need to determine the number of visits and the treatment required for your injury. We would also like to know your experiences after the accident and the effect it has had on your life. At the end of the information sheet is a consent form if you and/or your parents agree to be a part of our study.

We would like your permission to contact all the dentists who were involved in your care due to this accident. If this is acceptable, please have both you and your parents complete the attached form and return it in the envelope provided.

As part of this project, Dr. Phu-My Nguyen will contact you and your parents for a short telephone interview. Please notify us of any changes in address or phone number.

Thank you in advance for your participation in this important investigation. If you wish, we will send you a copy of the research results.

If you have any questions or concerns, please leave a message on Dr. Nguyen’s voice mail (416) 979-4750 extension 3042. She will return your call promptly.

Yours sincerely,

David J. Kenny, BSc, DDS, PhD, Dip Paed, MRCD(C)
Director of Dental Research and Graduate Studies
Professor of Dentistry, University of Toronto
Appendix II

Participant Information Sheet

The socioeconomic impact of avulsion injuries to the maxillary permanent incisors of children and adolescents

Principal Investigator:
Phu-My Nguyen, BSc, DDS
Department of Paediatric Dentistry, University of Toronto

Supervisor:
David J. Kenny, BSc, DDS, PhD, Dip Paed, MRCD(C)
Director Dental Research and Graduate Studies, University of Toronto & The Hospital for Sick Children

Introduction:
Having a front tooth knocked out of the mouth can make an impact on your life. Emergency treatment of such (avulsion) injuries is an emotionally charged event for both adolescents and parent(s). Immediate personal considerations include pain, fear of loss of front tooth/teeth, concern for other injuries, and appearance. Studies of the social and economic consequences are few and the actual “costs” of the injury are undetermined. Very little research has been done asking young people to comment on how their injury has affected their lives. It is important to do this research since it will give us reliable and valid information for improving how we explain the management of these injuries to other young people and their parents.

The Study
There are two parts to this study. One part is to determine the number of dental visits and the treatment required for your injury. That is why we need your consent to contact your dentist. The second part of the study, through a telephone interview, we are asking young people and their parents to talk about their experiences after the accident and the effect it has had on their lives. This is the chance for you to tell us what you think and feel about the injury and the treatment you received. This should take 20 to 30 minutes. The interviews will be completed separately and we request that you and your parents not discuss with each other about the interview until both of the interviews are completed.

Risks and Discomforts
There are no known risks from being in this study. If you do not want to join the study, or if you decide you want to stop before the end of the study, you are perfectly free to do so. The decision you make will not affect the kind of service you get from our dental clinic (if you are still receiving treatment there).
**Expected Benefits**
You may not receive direct, personal benefits from being in this study. We hope that the information we collect from you will help us improve how we communicate to other people who sustain dental injuries like the one you had.

**Confidentiality**
All the information that we collect about you will be kept strictly confidential. No information about you will be given out to anyone without your written permission, unless this information is required by law.

**Feedback**
We hope that you will feel comfortable about asking questions or giving us your comments about the study at any time. We will send you a letter about the results of the study once we have finished collecting all the information from everyone in the study. Please call Phu-My Nguyen (416-979-4750, extension 3042), if you have any questions or concerns.

Please fill out the bottom of this form:

I have read this form, and I understand what it means to be part of this study. I know that I can refuse to join the study, or quit the study at any time, without affecting the way I am treated at The HSC Dental Clinic. I have signed my name below to show that I have consented (17 + years old)/assented (16 years old and under) to join the study.

Print Your Name  Signature  Today’s Date

If child is 16 years old or younger, parents must also sign below. Parent(s) please also sign below if you consent to participate in our study.

Parent’s Name  Signature  Today’s Date

**Patient’s Address**

Street Number

City, Province

Postal Code

Phone Number

**Parent’s Address** (check if same)

Street Number

City, Province

Postal Code

Phone Number
Appendix III

Authorization for Release of Information for Research Purposes

Re: Patient Name:
Date of Birth:
HSC#:

Address: ________________________________
______________________________

Phone # ________________

Current Dentist: ____________________ 2. Previous/Other Dentist: ____________
Address: ________________________________
City: ________________
Phone Number: ________________

I give consent for Dr. Phu-My Nguyen to contact ________________________________
(patient’s name)
dentist(s) with regard to previous dental trauma treatment.
I hereby authorize the above named dentist(s) to release to Drs. D. Kenny/P. Nguyen,
Department of Dentistry, The Hospital for Sick Children radiographs (x-rays), and
clinical notes from the file of the above named patient.
I also consent to the release of any future research radiographs and clinical notes from the
records of the above named patient to Drs. Kenny and Nguyen until December 30, 2000.
I understand that all communications and materials are to be used for research only and
will be held in the strictest of confidence. No information that discloses the identity of
______________________________ will be released or published.

(patient’s name)

Signed: ________________________________

Print Name: ________________________________ Relation to Patient: ________________________________
(under 16 years old, parent must sign)

Date: ________________________________
Appendix IV

Dentist File Request

HSC Letterhead

Date

Dr. Dentist's name
Address

Dear Dr. Dentist's name:

Re: Patient Name
D.O.B.: Patient birth date

We are currently investigating the socioeconomic costs of avulsion injuries. Patient's name has consented to participate in our study and has indicated to us that he/she is a patient of yours.

Please find enclosed a copy of the Release of Information form. Could you please fax as soon as possible a copy of the clinical notes of patient name file regarding all treatment (including non-trauma related treatment) from accident date to the present. At this time, I am not requesting radiographs but may in the future request to view any pertinent radiographs.

Thank you in advance for your assistance in this matter. Additionally, if you have any other patients in your practice who have sustained avulsion injuries and you feel may consent to be included in our study, please let me know. If you have any questions please do not hesitate to contact me on my voice mail (416) 979-4925 extension 3042.

Yours sincerely,

Phu-My Nguyen, B.Sc., D.D.S.
Paediatric Dental Resident
Appendix V

Announcement letter prior to telephone survey

HSC Letterhead

Date

Parent's name
Address

Dear Parent's name:

As you may recall, last year you sent us a consent letter agreeing to take part in our study on “The socioeconomic impact of avulsion injuries to the maxillary permanent incisors of children and adolescents.”

In the next few days, I will be calling you and patient's name to conduct short telephone interviews to discuss your experiences with patient's name dental accident in accident date. When I call, I would like to speak to patient's name and you individually.

When you receive my phone call, if the time is not convenient for you, I encourage you to let me know and we can schedule a more appropriate time to conduct the interview. Alternatively, upon receipt of this letter, you may prefer to leave a message on my voice mail to let me know in advance when is the best time to call. My voice mail number is (416) 979-4750 extension 3042.

I would also like you to know that to show our appreciation for taking the time to speak with me, on behalf of The Hospital for Sick Children, you will each be receiving a cheque for $20 for completing the surveys.

Once again, thank you for your interest and support in our study.

Yours sincerely,

Phu-My Nguyen, B.Sc., D.D.S.
## Appendix VI

Excerpts from *ODA Suggested Fee Guide for General Practitioners*

ODA General Dentist Fee Guide 01/01/2000
†T = time (1.0 unit = 15 minutes)

<table>
<thead>
<tr>
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<th>Descriptor</th>
<th>T†</th>
<th>Suggested Fee</th>
</tr>
</thead>
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<tr>
<td>01202</td>
<td>Examination &amp; Diagnosis, limited oral, previous patient (recall)</td>
<td>0.5</td>
<td>24.20</td>
</tr>
<tr>
<td></td>
<td>-Examination with mirror and explorer of hard and soft tissues including checking of occlusion and appliances, but not including specific tests as for complete Oral Examination.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01204</td>
<td>Examination and Diagnosis, Specific</td>
<td>0.5-2.0</td>
<td>24.20-96.81</td>
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<tr>
<td></td>
<td>-Examination and evaluation of a specific situation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>01205</td>
<td>Examination &amp; Diagnosis, Emergency</td>
<td>0.5-2.0</td>
<td>24.20-96.81</td>
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<tr>
<td></td>
<td>-Examination &amp; diagnosis for the investigation of discomfort and/or infection in a localized area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>94302</td>
<td>Office or institutional visit</td>
<td>40.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Unscheduled, after regular scheduled office hours (in addition to the procedures performed)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9121x</td>
<td>Unusual time and responsibility requirement</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-In addition to usual procedures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x=1: one unit</td>
<td>1.0</td>
<td>56.47</td>
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<tr>
<td></td>
<td>x=2: two units</td>
<td>2.0</td>
<td>112.95</td>
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<tr>
<td></td>
<td>x=3: three units</td>
<td>3.0</td>
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<td></td>
<td>x=9: each additional unit three</td>
<td>1.0</td>
<td>56.47</td>
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<tr>
<td>01502</td>
<td>Examination, periodontal, specific‡</td>
<td>2.0</td>
<td>29.05-232.42</td>
</tr>
<tr>
<td>01605</td>
<td>Examination, Surgical, General‡</td>
<td>2.0</td>
<td>29.05-116.21</td>
</tr>
<tr>
<td></td>
<td>-History, Medical and Dental</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Clinical Examination including oral exam and may include in-depth analysis of medical status, medications, anesthetic and surgical risks, initial consultation with referring dentist or physician, parent or guardian</td>
<td></td>
<td></td>
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<tr>
<td>01602</td>
<td>Examination, Surgical, Specific‡</td>
<td>2.0</td>
<td>29.05-116.21</td>
</tr>
<tr>
<td></td>
<td>-Including radiographic examination and interpretation</td>
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<td></td>
</tr>
<tr>
<td>01701</td>
<td>Examination, Prosthodontic, Specific‡</td>
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<td>01801</td>
<td>Examination, Endodontic‡</td>
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<tr>
<td></td>
<td>-Complete endodontic examination and diagnosis</td>
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</table>
and/or complicated diagnosis. Recording history, charting, treatment planning and case history. Includes the following:
- History, Medical and Dental;
- Clinical examination and diagnosis may include vitality test/analysis, thermal test/analysis, cracked tooth test/analysis, Occlusal exams, percussion, palpation, transillumination, anesthetic test/analysis and mobility test/analysis.

<table>
<thead>
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<th>Code</th>
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<td>Examination, Endodontic, Specific‡</td>
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<tr>
<td></td>
<td>- Endodontic examination and evaluation of a specific situation in a localized area and vitality test analysis.</td>
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<td>116.21</td>
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**Diagnostic Radiographs††**

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<td>0211x</td>
<td>Periapical radiograph (single)</td>
<td>x=number radiographs</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td>x=2</td>
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<td>x=3</td>
<td>25.62</td>
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<td>x=4</td>
<td>28.69</td>
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<td>0213x</td>
<td>Occlusal radiograph</td>
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<td></td>
<td>x=1</td>
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<td></td>
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<td>25.21</td>
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<td>39.15</td>
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<td>Panoramic radiograph (one)</td>
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<td>Cephalometric radiograph (one)</td>
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<td>02941</td>
<td>Hand &amp; wrist radiograph</td>
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**Pain and Trauma Control**

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<td>x=9: each additional unit of time</td>
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<td></td>
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<td>1.0</td>
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<td>2011x</td>
<td>Caries/trauma/pain control</td>
<td>x=1: first tooth</td>
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<tr>
<td></td>
<td>- Removal of carious lesions or existing restorations and placement of sedative protective dressings, includes pulp caps when necessary, as a separate procedure</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

82
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price 1-2.0</th>
<th>Price 40.34-80.68</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013x</td>
<td>Trauma control, smoothing of fractured surfaces per tooth</td>
<td>1.0-2.0</td>
<td>40.34-80.68</td>
</tr>
<tr>
<td></td>
<td>x=1: first tooth</td>
<td>0.5</td>
<td>16.14</td>
</tr>
<tr>
<td></td>
<td>x=9: each additional tooth</td>
<td>0.5</td>
<td>16.14</td>
</tr>
</tbody>
</table>

**Restorative Services**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price 2.0</th>
<th>Price 64.54</th>
</tr>
</thead>
<tbody>
<tr>
<td>2311x</td>
<td>Permanent tooth restorations, tooth coloured, anterior, bonded technique</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>-Not to be used for veneer application or diastema closures</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x=1: one surface</td>
<td>2.0</td>
<td>64.54</td>
</tr>
<tr>
<td></td>
<td>x=2: two surfaces (continuous)</td>
<td>2.5</td>
<td>80.68</td>
</tr>
<tr>
<td></td>
<td>x=3: three surfaces (continuous)</td>
<td>2.75</td>
<td>111.01</td>
</tr>
<tr>
<td></td>
<td>x=4: four surfaces (continuous)</td>
<td>2.75-4.0</td>
<td>111.01-161.35</td>
</tr>
<tr>
<td></td>
<td>x=5: five surfaces (continuous)</td>
<td></td>
<td>11.01-161.35</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price 3.0</th>
<th>Price 145.22+L</th>
</tr>
</thead>
<tbody>
<tr>
<td>25711</td>
<td>Post, cast metal (including core) as a separate procedure</td>
<td>6.0</td>
<td>290.43+L</td>
</tr>
<tr>
<td></td>
<td>-Single section + Lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25721</td>
<td>Post, cast metal (including core) concurrent with impression for crown</td>
<td>3.0</td>
<td>145.22+L</td>
</tr>
<tr>
<td></td>
<td>-Single section + Lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25741</td>
<td>Post, prefabricated, retentive and cast core</td>
<td>4.0</td>
<td>193.62+L</td>
</tr>
<tr>
<td></td>
<td>-One post and cast core + Lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25754</td>
<td>Post, prefabricated, with composite core</td>
<td>3.0-5.0</td>
<td>145.22-242.03</td>
</tr>
<tr>
<td></td>
<td>-One post</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25771</td>
<td>Post, fabrication, temporary placement</td>
<td>1.0</td>
<td>40.34+E/L</td>
</tr>
<tr>
<td></td>
<td>-Per post + Emergency and/or Lab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27111</td>
<td>Crown, plastic, processed + Lab</td>
<td>8.0</td>
<td>387.24+L</td>
</tr>
<tr>
<td>27113</td>
<td>Crown, plastic, transitional, indirect + Lab</td>
<td>3.0</td>
<td>121.01+L</td>
</tr>
<tr>
<td>27121</td>
<td>Crown, plastic, direct, transitional (chairside)</td>
<td>4.0</td>
<td>161.35</td>
</tr>
<tr>
<td>27201</td>
<td>Crown, porcelain/ceramic/polymer glass jacket + Lab</td>
<td>10.0</td>
<td>564.73+L</td>
</tr>
<tr>
<td>27211</td>
<td>Crown, porcelain/ceramic/polymer glass fused to metal base + Lab</td>
<td>10.0</td>
<td>564.73+L</td>
</tr>
<tr>
<td>27601</td>
<td>Veneer, plastic, acid etch/bonded + Lab</td>
<td>5.0</td>
<td>258.16+L</td>
</tr>
<tr>
<td>27602</td>
<td>Veneer, porcelain/ceramic, acid etch/bonded + Lab</td>
<td>7.0</td>
<td>361.42+L</td>
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</tbody>
</table>

**Endodontic Services**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price 2.0</th>
<th>Price 80.68</th>
</tr>
</thead>
<tbody>
<tr>
<td>32221</td>
<td>Emergency Pulpotomy</td>
<td>2.0</td>
<td>80.68</td>
</tr>
<tr>
<td></td>
<td>-Permanent anterior tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32311</td>
<td>Emergency pulpectomy</td>
<td>2.0</td>
<td>80.68</td>
</tr>
<tr>
<td></td>
<td>-Permanent anterior teeth, one canal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3311x</td>
<td>Root canal, permanent tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x=1: one canal</td>
<td>8.0</td>
<td>322.70</td>
</tr>
</tbody>
</table>
x=5: retreatment

33601 Apexification/apexogenesis/induction of hard tissue repair
- To include: biomechanical preparation & initial placement of dentogenic media
- To exclude: final obturation
-one canal

33611 Re-insertion of dentogenic media
- Per visit, one canal

39201 Open and drain (separate emergency procedure)
- Anterior teeth

3931x Bleaching endodontically treated tooth
x=1: one unit of time
x=2: two units
x=3: three units
x=9: each additional unit over three

Prosthetics – Removable and Fixed

52101 Partial denture, acrylic base (transitional)
-Maxillary + Lab
5.0 201.69+L

5420x Partial denture adjustments
-Minor - after 3 months post insertion or by other than dentist providing prosthesis
x=1: one unit of time
x=2: two units
x=9: each additional unit over two

55301 Partial denture repairs/additions, no impression required
-Maxillary + Lab
0.5-1.0 20.33-40.34

55401 Partial denture repairs/additions, impression required
-Maxillary + Lab
1.0-3.0 40.34-121.01+L

62501 Pontics, porcelain fused to metal
279.70+L

62702 Pontics, acrylic/plastic/Composite, processed indirect (transitional) + Lab
279.70+L

67211 Retainers, porcelain/ceramic/polymer glass fused to metal + Lab
10.0 645.40+L

67341 Retainers, metal (external retention type)
-Acid etch and/or perforated bonded to abutment tooth + Lab
2.5 121.01+L

25761 Post attachment to endosseous integrated implants
-Screw/cemented
2.0-4.0 129.08-258.16

27213 Crown, porcelain/ceramic fused to metal base
-Screwed directly to an implant without the intervening post + Lab
7.0 451.78+L
### Oral and Maxillofacial Surgery

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Code</th>
<th>Amount (Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>71101 Extraction</td>
<td>71101</td>
<td>1.0 48.41</td>
</tr>
<tr>
<td>- Erupted teeth, uncomplicated, single tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71201 Extraction</td>
<td>71201</td>
<td>2.0 112.95</td>
</tr>
<tr>
<td>- Erupted teeth, surgical approach, requiring surgical flap and/or sectioning of tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7694x Replantation, avulsed tooth/teeth (including splinting)</td>
<td>7694x</td>
<td></td>
</tr>
<tr>
<td>x=1: first tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x=9: each additional tooth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7696x Repairs, lacerations, uncomplicated, intraoral or extraoral</td>
<td>7696x</td>
<td></td>
</tr>
<tr>
<td>x=1: 2 cm or less</td>
<td>7696x</td>
<td>1.0 56.47</td>
</tr>
<tr>
<td>x=2: 2-4 cm (complex)</td>
<td>7696x</td>
<td>1.0-2.0 56.47-112.95</td>
</tr>
<tr>
<td>x=3: 4-6 cm (complex)</td>
<td>7696x</td>
<td>2.0-4.0 112.95-225.89</td>
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<tr>
<td>79951 Implants, endosseous, integrated cylindrical; First stage surgical placement, maxilla per implant</td>
<td>79951</td>
<td>3.0 677.67+E</td>
</tr>
<tr>
<td>79953 Implants, endosseous, integrated cylindrical; Second stage exposure and temporization, maxilla per implant</td>
<td>79953</td>
<td>2.0 193.62+E</td>
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</tbody>
</table>

### Sedation and General Anesthesia

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Code</th>
<th>Amount (Units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>General anesthesia has</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Includes pre-anesthetic evaluation and post-anesthetic follow-up)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x=2: two units</td>
<td></td>
<td>2.0 142.69</td>
</tr>
<tr>
<td>x=3: three units</td>
<td></td>
<td>3.0 181.78</td>
</tr>
<tr>
<td>x=4: four units</td>
<td></td>
<td>4.0 220.85</td>
</tr>
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<td>x=5: five units</td>
<td></td>
<td>5.0 249.94</td>
</tr>
<tr>
<td>x=6: six units</td>
<td></td>
<td>6.0 299.01</td>
</tr>
<tr>
<td>x=7: seven units</td>
<td></td>
<td>7.0 338.37</td>
</tr>
<tr>
<td>x=8: eight units</td>
<td></td>
<td>8.0 377.16</td>
</tr>
<tr>
<td>x=9: each additional unit over eight</td>
<td></td>
<td>1.0 39.08</td>
</tr>
<tr>
<td>Nitrous oxide and oxygen conscious sedation</td>
<td>9241x</td>
<td></td>
</tr>
<tr>
<td>x=1: one unit of time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>x=2: two units</td>
<td></td>
<td>1.0 21.63</td>
</tr>
<tr>
<td>x=3: three units</td>
<td></td>
<td>2.0 37.77</td>
</tr>
<tr>
<td>x=4: four units</td>
<td></td>
<td>3.0 53.93</td>
</tr>
<tr>
<td>x=5: five units</td>
<td></td>
<td>4.0 70.05</td>
</tr>
<tr>
<td>x=6: six units</td>
<td></td>
<td>5.0 86.22</td>
</tr>
<tr>
<td>x=7: seven units</td>
<td></td>
<td>6.0 102.37</td>
</tr>
<tr>
<td>x=8: eight units</td>
<td></td>
<td>7.0 118.50</td>
</tr>
<tr>
<td>x=9: each additional unit over eight</td>
<td></td>
<td>8.0 134.64</td>
</tr>
<tr>
<td>Oral sedation</td>
<td>9262x</td>
<td>1.0 25.97</td>
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</tbody>
</table>

85
**Professional Consultations and Administrative Fees**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Formula</th>
<th>Rate</th>
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<tbody>
<tr>
<td>9311x</td>
<td>Consultation with member of the profession, in or out office</td>
<td>( x=1: 1.0 )</td>
<td>40.34</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( x=2: 2.0 )</td>
<td>80.68</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( x=9: 1.0 )</td>
<td>40.34</td>
</tr>
<tr>
<td>9312x</td>
<td>Dental legal report</td>
<td>( x=1: 1.0 )</td>
<td>I.C.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( x=9: 1.0 )</td>
<td>I.C.</td>
</tr>
</tbody>
</table>
| 9331x  | Extraordinary time spent in forwarding predetermination records to third     | \( x=1: 1.0 \) | 12.35+
|        | parties plus expenses                                                        | \( x=2: 2.0 \) | Exp   |
|        |                                                                              | \( x=9: 1.0 \) | 12.35 |

**Abbreviations:**
- **E** = Emergency fees
- **Exp** = Expenses
- **L** = Lab expenses

†† Diagnostic radiographs were not assigned time units according to *ODA Suggested Fee Guide*

‡‡ Based on OADS Specialist Fee Guide 01/01/2000. No time units were given in the specialist fee guide. Based on number of units assigned to other examinations, consultations were assigned two units.
Appendix VII

Trauma Survey - Parent

Name
Date
Time

This is Dr. Phu-My Nguyen from The Hospital for Sick Children calling. Could I please speak with parent's name.

Good evening Mr./Mrs. ____, I sent you a letter a few weeks back informing you that I would be calling you and patient's name to conduct a telephone interview regarding the dental accident patient's name had in accident year. The interview will take approximately 20 to 30 minutes for you and 15 minutes for your son/daughter. Is this a good time for the both of you?

No – When is a good time to call back so I can speak with both of you?
Yes – Thank you. It would be best to conduct the 1st part of the survey without patient's name present to hear your answers. I would also like you to know that to show our appreciation for taking the time to speak with me, on behalf of The Hospital for Sick Children, you will be receiving a cheque for $20 for each complete survey.

Additionally, if any of the questions are unclear, please feel free to let me know. This will aid in our refinement of the surveys.

Firstly, to estimate the financial burden of patient's name accident, I would like to ask you a few questions about yourself.

Demographics

1) What is your relationship to (pt)?
2) What is your birth date?
3) What is your husband/wife’s birth date?
4) What was your occupation at the time of the accident?
5) Were you working full or part-time?
6) What was your husband’s occupation at the time of the accident?
7) Was he working full or part-time?
8) Has there been a major change in yours or your husband’s occupation during the time of ongoing dental treatment for the accident?

Etiology

Next I would like to ask a few questions regarding child’s name accident on date. Try to remember as best as you can, but if you cannot recall, please let me know.

9) Where did the accident happen?
10) What time of day did the accident happen (morning, afternoon, evening)?
11) How did the accident occur?
12) Where did you go for the emergency treatment?
13) Why did you choose Sick Kids?
14) Who came with (pt) for the emergency treatment?
15) What time of day did you get to the hospital/clinic?
16) Did you have to leave work to get to the hospital/clinic?
17) Did (pt) have to leave school to get to the hospital/clinic?

**Functional variables**

The next questions are about how patient's name functioned with the replanted front tooth during treatment and follow-up visits. Please rate the following questions on a scale of 1 (no difficulty) to 7 (very difficult)

18) In the first 6 months after the accident, how much difficulty did patient's name have biting any kind of food?

19) Is the replanted tooth still in the mouth? Y/N
   a) **If yes:** How much difficulty does patient's name have biting any kind of food now? Please rate the difficulty on the same scale of 1 to 7.
   b) **If no:** What is in its place now?
   c) How much difficulty does (pt) have biting any kind of food with the replacement tooth on the same scale of 1 to 7?

20) On a scale of 1 to 7 (1 being not at all concerned, 7 being extremely concerned)
   a) How concerned were you in the past about something happening to the front teeth when biting?
   b) Please describe.

21) On the same scale,
   a) How concerned are you now about something happening to the front teeth when biting?
   b) Please describe.

**Personal Variables**

22) Do you remember what the dentist did to treat patient's name injured teeth?
   a) Y/N
   b) What did he/she do?

23) How long did it take for the dentist to see you
   a) For the emergency treatment?
   b) For the follow-up appointments?

24) How long did the emergency treatment take?
25) Do you think about the trauma?
   a) Y/N
   b) How often?

26) On a scale of 1-7 (1 being not very anxious and 7 being extremely anxious), how anxious do you feel about the future of *patient’s name* injured teeth or their replacement?

**Social Variables**

27) Has the injury to *patient’s name* teeth affected any activities or plans?
   a) Y/N
   b) Please explain.

28) Did *patient’s name* have to stay home from school right after his accident?
   a) Y/N
   b) How much time?
   c) Why?

29) Did *patient’s name* have to take time out of school for dental appointments?
   a) Y/N
   b) Approximately how much time? Please choose from one of the following:
      i) __ 1-2 hours
      ii) __ ½ a day
      iii) __ all day

30) Did you or your spouse have to take time off work or usual activity to take *patient’s name* to his/her appointments?
   a) Y/N
   b) How much time? Please choose from one of the following:
      i) __ 1-2 hours
      ii) __ ½ a day
      iii) __ all day

31) What was the travel time it takes for you to bring (pt) to the hospital?

32) How did you get to the hospital?
   a) __ Car
   b) __ Public transportation
   c) __ Taxi
   d) __ Walk
   e) __ Other

33) Who was the main person who brought *patient’s name* to his/her dental appointments dealing with his/her injured teeth or was it equally shared with another adult?
If tooth is still present:
34) On a scale of 1 to 7 (1 being very dissatisfied and 7 being very satisfied),
   a) How satisfied are you with the colour of the tooth?
   b) What do you like about the tooth?
   c) What do you not like about the tooth?

If the teeth have been extracted:
35) Does patient's name have a problem with wearing a replacement tooth?
   a) Y/N
   b) Please describe.

If pt is wearing RPD/:
36) On a scale of 1 to 7 (1 being very worried, 7 being not at all worried),
   a) How worried about (pt) losing the denture?
   b) Why?

37) On the same scale of 1 to 7,
   a) How worried are you about (pt) breaking the denture?
   b) Why?

38) On a scale of 1 to 7 (1 being very dissatisfied, 7 being very satisfied)
   a) How satisfied are you with the appearance of the denture?
   b) Why?

Information
39) At the time you presented to the hospital for emergency treatment, what did the
dentist explain to you about (Y/N):
   a) How long the tooth would be in the mouth?
   b) Did s/he tell you about long-term costs?
   c) Did s/he explain about the need for root canal treatment?
   d) Did s/he explain about the number of appointments that you would be expected to
      attend?
   e) Did s/he explain about the potential for loss of the replanted tooth?

40) At the follow-up appointments, were you told again of (Y/N)
   a) How long the tooth would be in the mouth?
   b) Long-term costs?
   c) The need for root canal treatment?
   d) The number of appointments needed that you would be expected to attend?
   e) The potential for loss of the replanted tooth?

41) If you knew at the time of the accident what you know now, would you have
    requested the incisor be replaced in the mouth or left out?
42) If the tooth was extracted after the accident,
   a) Do you wish you had it removed sooner? Y/N
   b) Why?

43) How did the dentist who performed the emergency treatment assist your decision-making?

44) The following is a list of aspects of first aid treatment. Please choose which are the 3 most important aspects of the emergency treatment. 1. 2. 3.
   a) trust in your dentist
   b) prompt treatment
   c) information regarding outcome of injured teeth
   d) getting your child out of pain
   e) replanting the tooth so that your child will still have a front tooth for school

45) Is there anything you wish you were informed of
   a) During the emergency treatment?
   b) Please explain.

46) Is there anything you wish you were informed of
   a) at follow-up visits?
   b) Please explain.

**Subjective**

47) What were your long-term expectations for tooth failure?

48) On a scale of 1 to 7 (1 being strongly disagree and 7 being strongly agree), please rate the following statements:
   a) It is important that the injured tooth is in the mouth through the critical teenage years.
   b) It is acceptable that the injured tooth is slightly different colour than the other teeth.
   c) It is acceptable that the injured tooth is “shorter” than the adjacent teeth.

49) Please choose from one of the following. How much are you willing to spend to save one front tooth?
   a) ☐ Less than $500
   b) ☐ $500-1000
   c) ☐ $1000-$2000
   d) ☐ Over $2000

50) Who paid for your child’s
   a) Emergency treatment of the injured teeth? (insurance, self, government programme or combination)
b) Follow-up treatment (root canals, fillings/ crowns, surgery, dentures, etc)?

51) This concludes the 1st part of the survey. Are there any concerns or additional comments you would like to add?

Thank you for your time and support of this study. If you would like a copy of our results, please notify me and I will be happy to send you a copy when it is available.

Now, I would like to speak with (pt) for the 2nd part of the survey. It is best if you not be present during his/her interview. You are free to discuss the interview with each other when both interviews are complete. Could you please transfer the phone to (pt)?
Appendix VIII

Trauma Survey – Patient

Name: 
Date: 
Time: 

Thank you for agreeing to take part in our survey. Your part of the survey should take approximately 15 minutes. I would also like you to know that to show our appreciation for taking the time to speak with me, on behalf of The Hospital for Sick Children, you will be receiving a cheque for $20 for each complete survey.

Demographics

1) Firstly, I’d like to ask a few questions about you.
2) Do you have any brothers and sisters?
3) How many and where do you stand in the family?
4) What grade were you in when you had your accident?
5) What grade are you in now?

Etiology

Next I would like to ask a few questions regarding your accident on date. Try to remember as best as you can, but if you cannot recall, please let me know.

6) Where did the accident happen?
7) How did the accident occur?
8) Why did you choose Sick Kids’ Clinic?
9) Who came with you for the emergency treatment?
10) What time of day did you get to the hospital?
11) Did your mom or dad have to leave work to get your to the hospital?
12) Did you have to leave school to get to the hospital?

Functional Variables

The next questions are about how you are able to function with the replanted front tooth during treatment and follow-up visits. Please rate the following questions on a scale of 1 (no difficulty) to 7 (very difficult).

13) In the first 6 months after the accident
   a) How much difficulty did you have biting any kind of food?
   b) What types of foods gave you difficulty?

From parent survey, if tooth still in mouth:
14) How much difficulty do you have biting any kind of food now? Please rate the difficulty on the same scale.

*If tooth no longer in mouth:*

15) How much difficulty do you have biting any kind of food with the replacement tooth on the same scale 1 to 7?

**Personal Variables**

16) What happened right after the tooth was knocked out?

17) Who looked after
   a) You at the time of the accident?
   b) The tooth at the accident site?

18) What did you do with the tooth before you got to the hospital?

19) Do you remember what the dentist did to fix your front teeth?
   a) During the emergency treatment?
   b) Please describe.
   c) During follow-up treatments?
   d) Please describe.

20) On a scale of 1 to 7 (*1 being never, 7 being always*),
   a) How often do you think about the trauma?
   b) Do you have dental fears? Y/N
   c) Did the trauma contribute to it? Y/N

21) On a scale of 1 to 7 (*1 being not very worried, 7 being extremely worried*), how worried are you about the future of your front teeth or their replacement?

**Social Variables**

22) Has the injury to your teeth
   a) Affected any activities or plans? Y/N
   b) What type of plans?

23) Did you have to take time out of school
   a) Immediately after the accident?
   b) How much time?
   c) For dental appointments?
   d) Y/N
   e) How much time? Please choose from the following:
      i) 1-2 hours
      ii) ½ a day
      iii) all day
If the teeth have been extracted:
24) Do you have a problem with wearing a flipper/denture?
25) Do you have a fear of losing them (RPD)?
26) Do you have a fear of breaking them?
27) Are you satisfied by its appearance?
28) What do you expect to happen to your tooth (or the space) in the future?
29) What was the worst thing about the accident?
30) Were there any good things about the accident?
31) Do you use a mouthguard now when you play sports?

Esthetic Evaluation

If tooth still present
32) On a scale of 1 to 7 (1 being very dissatisfied and 7 being very satisfied)
   a) How satisfied are you with the colour of your replanted tooth?
   b) On the same scale of 1 to 7, how satisfied are you with the position of your replanted tooth?

If pt has prosthetic tooth
33) On a scale of 1 to 7 (1 being very dissatisfied and 7 being very satisfied)
   a) How satisfied are you with the colour of the false tooth?
   b) On the same scale of 1 to 7, how satisfied are you with the shape/position of the false tooth?

34) On a scale of 1 to 7 (1 being strongly disagree and 7 being strongly agree), please rate the following statements:
   a) It is important that the injured tooth is in the mouth through the critical teenage years.
   b) It is acceptable that the injured tooth is slightly different colour than the other teeth.
   c) It is acceptable that the injured tooth is “shorter” than the adjacent teeth.

35) If you knew at the time of the accident what you know now, would you request the tooth be replaced in the mouth or left out?

36) This concludes our survey. At this point, are there any comments you would like to add? Thank you again for your time.
### Appendix IX

**Calculation of first year treatment costs and time**

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### Appendix X

**Calculation of worst-case scenario treatment costs and time**

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