The Clinical Relevance of Paediatric Access Targets for Elective Dental Treatment Under General Anaesthesia

by

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A thesis submitted in conformity with the requirements for the degree Master of Science

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Abstract

The purpose of this study was to evaluate the clinical relevance of access targets for elective dental general anaesthesia (GA) by assessing incremental changes in dental disease burden over wait times at SickKids. A retrospective review of dental records were completed for 378 children who were prioritized by their dental and medical status. A scale was developed to measure cumulative dental disease burden over time. Statistically significant correlations were identified between cumulative disease burden and wait times for priority IV (p = 0.004), the entire sample (p < 0.003), DOSDCADA (p = 0.005), comorbid (p = 0.036), healthy (p = 0.0002), female (p = 0.014) and male (p = 0.008) groups. The mean cumulative disease burden was not different between matched healthy and cormorbid groups (p = 0.38). A trend of increasing dental disease burden for children with longer wait times for dental GA was found but not clinically significant.
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“Experience: that most brutal of teachers. But you learn, my God do you learn.”

- C.S. Lewis

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TABLE OF CONTENTS

Literature Review

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Canadian public health care</td>
<td>1</td>
</tr>
<tr>
<td>II. Wait times in Canada</td>
<td>3</td>
</tr>
<tr>
<td>III. Wait lists and wait times</td>
<td>4</td>
</tr>
<tr>
<td>IV. Wait time definitions</td>
<td>5</td>
</tr>
<tr>
<td>V. Management of wait lists</td>
<td>7</td>
</tr>
<tr>
<td>a. Supply-side strategies</td>
<td>7</td>
</tr>
<tr>
<td>b. Demand-side strategies</td>
<td>10</td>
</tr>
<tr>
<td>VI. Wait times in New Zealand</td>
<td>12</td>
</tr>
<tr>
<td>VII. Wait times in Spain</td>
<td>13</td>
</tr>
<tr>
<td>VIII. Development of priority scoring systems</td>
<td>15</td>
</tr>
<tr>
<td>a. Point-count measures in prioritization</td>
<td>15</td>
</tr>
<tr>
<td>b. New Zealand</td>
<td>16</td>
</tr>
<tr>
<td>c. Western Canada</td>
<td>20</td>
</tr>
<tr>
<td>i. WCWL Hip and Knee Joint Replacement</td>
<td>22</td>
</tr>
<tr>
<td>ii. WCWL Cataract Surgery</td>
<td>23</td>
</tr>
<tr>
<td>iii. WCWL General Surgery</td>
<td>23</td>
</tr>
<tr>
<td>iv. WCWL Children’s Mental Health Services</td>
<td>24</td>
</tr>
<tr>
<td>v. WCWL Magnetic Resonance Imaging</td>
<td>25</td>
</tr>
<tr>
<td>d. Spain</td>
<td>26</td>
</tr>
<tr>
<td>e. Summary</td>
<td>32</td>
</tr>
<tr>
<td>IX. Reliability</td>
<td>34</td>
</tr>
<tr>
<td>a. WCWL reliability studies</td>
<td>34</td>
</tr>
<tr>
<td>i. Hip and Knee Joint Replacement</td>
<td>34</td>
</tr>
<tr>
<td>ii. Cataract Surgery</td>
<td>35</td>
</tr>
<tr>
<td>iii. General Surgery</td>
<td>36</td>
</tr>
<tr>
<td>iv. Children’s Mental Health Services</td>
<td>36</td>
</tr>
<tr>
<td>v. Magnetic Resonance Imaging</td>
<td>37</td>
</tr>
<tr>
<td>b. International reliability studies</td>
<td>37</td>
</tr>
<tr>
<td>i. New Zealand</td>
<td>37</td>
</tr>
<tr>
<td>ii. Spain</td>
<td>38</td>
</tr>
<tr>
<td>c. Summary</td>
<td>39</td>
</tr>
<tr>
<td>X. Access targets</td>
<td>41</td>
</tr>
<tr>
<td>XI. Public reporting of wait lists in Canada</td>
<td>44</td>
</tr>
<tr>
<td>a. Problems with reporting</td>
<td>47</td>
</tr>
<tr>
<td>XII. Consequences of waiting</td>
<td>48</td>
</tr>
<tr>
<td>a. Consequences of wait times in medicine</td>
<td>49</td>
</tr>
</tbody>
</table>
I. Canadian Public Health Care

Public health care is a fundamental value of Canadian society (Klatt, 2000). The Canada Health Act, enacted in 1984, specifies the principles of public health care that ensure core medical services to Canadians based on need rather than the ability to pay (Health Canada, 2005). Public health insurance was established in ten provinces and three territories since January 1, 1971 (Coyte, 2001). Each provincial or territorial government is responsible for the administration, financing and delivery of its own public health care. Therefore, the organization of each provincial or territorial health delivery system is unique and developed to suit the requirements of its particular demographics. Each province or territory qualifies for federal funding of public health care only if the criteria of comprehensiveness, universality, portability, accessibility and public administration, outlined in the Canada Health Act, are met (Health Canada, 2005; Klatt, 2000).

Public health services in Canada are funded by federal tax contributions, as well as provincial taxation and in certain provinces, by health insurance premiums and payroll taxes (Klatt, 2000). The health budget in Ontario is funded by the federal tax revenue (30%) and various provincial taxes (70%) (Coyte, 2001). Despite the public funding of medical services, health care is mainly provided by the private sector through self-employed physicians. These private providers charge on a fee-for-service basis but Canadians do not receive a bill for the costs incurred. Provincial ministries of health reimburse physicians based on a health insurance fee schedule set by each
province. Furthermore, public hospitals are privately owned, not-for-profit organizations that are managed by community boards or trustees. Hospitals receive an annual global operating budget from provincial health ministries that is funded by public monies (Irvine et al., 2005; WHO, 1996).

Health care costs dominate government spending in Canada when compared to other areas such as education and economic development (Coyte, 2001). Health expenditures in 1960 represented 5.5 per cent of the Gross Domestic Product (GDP) in Canada (Coyte, 2001). The rate of government spending on health care decreased annually from 1993 to 1997 but then quickly rose after 1998 and surpassed the rate of GDP growth (CIHI, 2008). The reasons for increased health costs included a rise in the number of health practitioners and growth in health care utilization by the population (Coyte, 2001). By 2007, the Canadian government was spending 10.1 percent of GDP on health care (OECD, 2009a).

Coincident with a Canadian economic recession, 1991 to 1998 represented a period of fiscal restraint, in which federal and provincial governments reduced the rate of spending on health care (Coyte, 2001). Over the last quarter century, a shift in health care spending was seen with less funding to hospitals and more towards pharmaceuticals, home care and community care (Coyte, 2001). Cutbacks in hospital expenditures were evident when the total health spending in Canada fell from 44 per cent in 1975 to 32 per cent in 1997 (Klatt, 2000). In the face of revenue shortfalls, advances in medical technology and drug development helped to reduce hospital costs and recovery times through increased efficiency of health care delivery. However, new technology proved to be costly and fueled an increase in demand for medical care from a
population with longer life expectancy (Farnsworth, 1991; Irvine et al., 2005). Hospitals reduced their capacity to treat patients in response to the pressures of limited resources (Irvine et al., 2005). Reduced capacity coupled with increased demand produced longer waits for service (Coyte, 2001, Hudson & Glynn, 2004, Klatt, 2000).

II. Wait Times in Canada

National agencies reported that many Canadians were waiting for health care while in pain and placed on wait lists that were non-standardized, poorly monitored and misleading to the public (McDonald et al., 1998). Statistics Canada reported that about 40 per cent of Canadians experienced pain that affected their lives during the wait for medical services (Sanmartin et al., 2002). About half of patients waiting for elective surgery (44%) or diagnostic services (68%) experienced “worry, stress or anxiety” (Sanmartin et al., 2002).

Pressures were placed on the government to improve access to health care and manage wait lists. In September 2004, federal, provincial and territorial governments made commitments “to achieve meaningful reductions in wait times” by March 31, 2007 in five priority areas: sight restoration, diagnostic imaging, cancer care, cardiac care and joint replacement (Health Council of Canada, 2007). The Federal government allotted $5.5 billion to a Wait Times Reduction Fund as part of a 10-year plan to improve wait times. In addition, the Federal government instituted a “Patient Wait Times Guarantee” that, in effect, enjoined the government to provide health care in a timely manner even if it required treatment in another jurisdiction at no cost to the patient (Picard, 2007).
Long wait times for health care procedures have also received attention in the medico-legal arena with the case of Chaoulli v. Quebec (Attorney General) (2005). After losing twice in the lower courts, Dr. Jacques Chaoulli, along with Mr. George Zeliotis, took their appeal arguing against the prohibition of private medical insurance in Quebec before the Supreme Court of Canada (Pinker, 1999). Zeliotis was an elderly patient waiting over a year for hip replacement surgery and Chaoulli was a Quebec physician not allowed to provide private medical services in a publicly funded system. On June 2005, the judges ruled against the Quebec ban on private health insurance as it violated the rights of Canadians with public health insurance in the face of long wait times. The Court stated in their report that “access to a waiting list is not access to health care” (Chaoulli v. Quebec (Attorney General), 2005). This court decision produced more public interest in wait times and a greater incentive for the government to address the issues of health care accessibility.

III. Wait lists and wait times

The terms, wait list and wait time, are used throughout the literature and one cannot exist without the other. A wait list is a group of patients in a queue for health services that arises when the supply of patients exceeds the available medical capacity. Despite negative attention from the media, wait lists are not necessarily attributes of a failing health care system. The absence of wait lists would indicate suboptimal use of the available surgical resources (Schaafsma, 2006). Wait lists reflect a constant demand for surgery that prevents the underutilization of hospital capacity (Street et al., 1996). Edwards (1997) stated that delays for treatment are advantageous in patient management since over time, some conditions may improve and patients may reconsider their decision to treat. However, wait lists may also occur due to truly insufficient surgical capacity,
variability in supply and demand for elective procedures or an ineffective health care system designed to hinder access to care (Walley et al., 2006). Wait time is commonly known as the period of waiting experienced by the patient once they enter the wait list until completion of treatment. However, some argue that the process of waiting can start as early as when a patient develops symptoms and seeks medical care (CFPC, 2004). Wait times become an issue when the treatment outcomes of a medical procedure are time-sensitive and the condition of the patient worsens over time. For example, a 2-year wait for a life-saving procedure such as a heart transplantation is more problematic than waiting a shorter period of time for minor surgery (Lewis et al., 2000). A wait list is in constant flux as patients complete their treatment and are removed from the wait list as new patients are added to the list (Hadorn et al., 2000).

IV. Wait time definitions

Five wait times are discussed in the literature: waits for primary care, waits to see a specialist, waits to receive hospital-based services, wait for aftercare and total wait time (Hudson & Glynn, 2004; Sanmartin et al., 2003). A 2004 poll conducted by Decima Research for the College of Family Physicians of Canada (CFPC) revealed differences in the beliefs of Canadians with regard to when wait times for medical care should begin. Forty-six per cent of Canadians thought wait times should begin upon consultation with the primary care provider while 33 per cent felt that waiting started as soon as the patient experienced medical problems and sought care. Only 15 per cent believed wait times should begin at the specialist visit (CFPC, 2004). Wait time definitions will need to be explicit and consistent across jurisdictions and among providers to allow for comparisons and accurate reporting (Sanmartin et al., 2003).
Typically, the first wait time experienced by a patient is the wait for primary care. It is defined as the waiting period from when a patient requests an appointment to the date of primary care consultation. Next, the wait time for a specialist consultation begins from the date of referral by the primary care provider (e.g. family physician) to the time of visit with the specialist. This is defined as Wait 1 (W1) by the Ontario government (Hudson & Glynn, 2004).

Once a patient and specialist have come to a decision to treat with surgery or a decision to order diagnostic imaging, the time waiting for these services is known as Wait 2 (W2) in Ontario (Hudson & Glynn, 2004). The decision to treat can be made upon initial consultation with the specialist however in some cases, patients may be referred to a second specialist for further assessment before a treatment decision can be reached. Diagnostic imaging such as computed tomography, magnetic resonance imaging (MRI) or ultrasound scans may be ordered after a decision to treat is made to assist the specialist during surgery and would be a component of their W2, the wait for surgery. However, there are circumstances when the decision to order diagnostic imaging may be required before the decision to treat can be made. Long wait times for diagnostic imaging may prolong the total wait time. In these cases, the wait for diagnostic testing is also considered a W2 in Ontario but separate from the wait for surgery. After treatment has been provided, some patients require home care or rehabilitation. The time from completion of treatment to homecare or rehabilitation is an additional wait time known as Wait 3 (W3) in Ontario (Hudson & Glynn, 2004).
V. Management of Wait Lists

a. Supply-side strategies

Supply-side strategies work to improve capacity of the health care system by allocating additional funding or using available capacity in the private sector or abroad (Hurst & Siciliani, 2003; Sanmartin et al., 2000).

To increase the available capacity in the public sector, provisional funding may be allocated to hospitals based upon long wait lists and wait times, upon completion of additional cases beyond the normal case-load, upon the delivery of extra-activity with wait time reduction or upon increased utilization of existing capacity (Siciliani and Hurst, 2005). However the relationship between wait times and capacity is controversial. A paper by the Organisation for Economic Co-operation and Development (OECD) assessed wait time variations for elective surgery and found a clear negative association between wait times and capacity (Siciliani and Hurst, 2003). This paper revealed that an increase of 0.1 practicing physicians and specialists in a population of 1000 people was associated with a reduction of mean wait times of 8.3 and 6.4 days and a reduction of median wait times of 7.6 and 8.9 days, respectively (p = 0.01) (Siciliani and Hurst, 2003). However all physicians that worked in public or private sectors or both, as well as those working in industry, administration or research, were included in the analysis and could not be separated from the data set. An increase in total health expenditure per capita of $100 was also associated with a reduction of mean wait time of 6.6 days and median wait time of 6.1 days (p = 0.01) (Siciliani and Hurst, 2003). The total health expenditure factor encompassed hospital expenditures as well as other areas such as pharmaceuticals and public health that made it difficult to solely measure the cost of hospital capacity (e.g. acute care beds, hospital personnel).
Furthermore, financial incentives to decrease wait times may differ among OECD countries to affect productivity and demand for treatment, thereby affecting wait times. Despite the statistically significant associations, limitations in data collection and differences in incentives among institutions may have affected the results. Martin and Smith (1999) developed a supply and demand model to predict the utilization rate and waiting time based on the pattern of need and the hospital capacity available. Their model suggested that an increase in hospital capacity could reduce wait times but that resource allocation must be maintained over time to achieve long term improvements in wait times (Martin and Smith, 1999).

Several studies show a different relationship between wait times and capacity that is directly proportional. Decoster et al. (1998) reported an increase of 32 per cent in the volume of cataract surgery in Manitoba, Canada as well as a rise in median wait times for cataract surgery between 1992/93 (4265 procedures performed; median wait time 15.7 weeks) and 1996/97 (5619 procedures performed; median wait time 17.9 weeks). Similarly, the number of coronary bypass surgeries in Ontario increased by 15 per cent from 1992/93 to 1995/96 however, the median wait time also followed with an increase from 17 to 23 days (Naylor et al., 1997). Goldacre et al. (1987) found a significant positive correlation between the quarterly number of admissions from the wait list for elective surgery and the length of the wait list at the end of each quarter from January 1974 to December 1983 in the United Kingdom ($r = 0.35, \text{df} = 38, p < 0.05$).

Worthington (1987) described the “feedback” mechanism to explain the counter-intuitive parallelism between wait times and resource provision. When the hospital capacity increases, the length of wait lists decrease and in turn, general practitioners will refer patients to specialists with shorter wait lists thereby increasing demand and offsetting any improvements made in wait
list reduction. Street and Duckett (1996) mention that in Australia the provision of extra resources is an incentive for hospital managers and specialists to maintain long wait lists for the guarantee of continual funding.

Private health care is another supply-side approach that has been considered to reduce long wait lists. This approach assumes that individuals who cannot afford private medical services will have their wait times reduced by those who have the finances for expedited health care and that removes them from the public wait list. However, the literature provides no evidence to support this assumption. Sanmartin et al. (2000) discussed the adverse effects of introducing private care in a public health care system in terms of human capacity (e.g. physicians and nurses) moving to the private sector and delaying public wait times in the public sector. Ophthalmologists who worked for both health care sectors in Manitoba had longer median wait times for public cataract surgery than eye specialists who only worked in the public system (Decoster et al., 1998). In the United Kingdom (UK), Richmond (1996) reported that public wait lists for the National Health Service (NHS) were long despite utilization of the private sector by 13 per cent of the population. In addition, the majority of private services rendered included hip replacement, hernia, hemorrhoids, gynecologic and ophthalmic procedures, which represented procedures with the longest wait times in public health care. Yates found that median wait times of NHS patients for inpatient or day case admissions increased from 32 to 42 days and for private patients, reduced from 11 to 9 days between 1989-90 and 1994-95 (Hinchliffe et al., 2000). There were regulations that limited NHS physicians from earning more than 10 per cent of their income from private practice in the UK (Richmond, 1996). However, there was no independent audit process to prevent abuse of these policies among the medical profession (Light, 1996). Therefore,
management of the increasing demand for medical services may provide a more cost-effective and definitive approach for policy-makers to reduce wait times in public health care.

b. Demand-side strategies

Demand-side strategies attempt to decrease wait times by patient prioritization on a wait list, reducing need for services or improving management of the waiting process (Hurst & Siciliani, 2003; Sanmartin et al., 2000).

Prioritization of patients on wait lists has been based on patient need for treatment and potential to benefit from the procedure (Derrett et al., 2003; Noseworthy et al., 2003). Countries with public health care have had different approaches to patient prioritization on wait lists. A less formal approach of classifying patient need into two to four levels was utilized in Spain (‘high-priority’ and ‘low-priority’), in Sweden (‘very urgent’, ‘urgent’, and ‘non-urgent’), in Australia and Italy (admission within 30 days, within 90 days, within 12 months) (Hurst & Siciliani, 2003). Alternatively, New Zealand and Canada led the development of comprehensive priority scoring systems to grade patient need and access to elective surgical services (Casas et al., 2007; Derrett et al., 2003; Naylor et al., 1995; Noseworthy et al., 2003; Trypuc et al., 2006). Access targets or maximum acceptable wait times were also assigned to priority levels in some systems to ensure that patients were treated within an appropriate window of time based on clinical evidence (Canadian Child and Youth Health Coalition, 2006).

Auditing wait lists would reduce the apparent demand and increase the efficiency of delivery of medical services by removing patients from the list who later declined surgery, had already been
treated, planned to have treatment elsewhere or could not be located (Fraser, 1991). Independent audits provide an objective perspective to the current state of wait lists but the systematic self-review of wait lists was also demonstrated to be effective by Elwyn et al. (1996) where 32 patients (28%) were removed from a wait list due to inaccuracies.

Lastly, the management of wait lists would improve with a centralized wait list, methods to reduce non-attendance and the number of follow-up visits with the physician (Sanmartin et al., 2000). The use of a centralized booking system coordinates wait lists of physicians in a particular region or for a specific treatment procedure and allows for referrals to be sent to clinicians with available capacity (French et al., 1990). Non-attendance at surgical appointments also contributes to inefficiencies in wait list management. Turner et al. (1991) reported that outpatient wait times could have reduced from six months to one week if the non-attendance of patients was known beforehand so that cancellations could be filled in advance. Methods to remind patients of upcoming appointments, such as text messaging (Hogan et al., 2008; Kruse et al., 2009), were effective in reducing non-attendance in clinics and increasing the efficiency of wait lists. Modifications in the extent of patient follow-up in clinic would also improve wait times. Davies et al. (1994) found that pain clinics in the UK that scheduled more frequent appointments for their existing patients had less time to assess their new patients. Solutions for reducing clinic appointments included patient contact by telephone or mail, transfer of care back to a primary provider or follow-up by nursing staff (Davies et al., 1994). Both supply-side and demand-side strategies have their advantages and disadvantages however a combination of both strategies is most effective as a long-term solution for improving wait times in elective treatment.
VI. Wait Times in New Zealand

New Zealand has a two-tiered health care system that is predominantly publicly funded but in which 30 per cent of the population is covered under private health insurance (McLeod et al., 2004). The national Ministry of Health governs the public health sector but 21 local district health boards (DHBs) manage resources for all health services in their district (McLeod et al., 2004).

In the early 1990s, New Zealand began a transformation of its health care system due to economic collapse and to improve access to elective services (Gauld and Derrett, 2000). The government established the Core Services Committee (CSC) to help define the core medical services that would be funded under public health care and to involve the public in its discussions. In 1993, the CSC commissioned reports to determine the current state of national wait lists. Patients waiting for elective surgery were classified as urgent, semi-urgent or routine based on clinical judgment of the treating specialist. Concerns with regard to the objectivity and equity of this prioritization system were reported in the literature (Gauld and Derrett, 2000). Fraser et al. (1993) revealed that wait lists in New Zealand had doubled in length from 1972 to 1992. Furthermore, this national report showed that wait lists had failed to measure hospital productivity and did not provide patient certainty on wait times for treatment (Fraser et al., 1993). The approach of implicit priority setting by individual clinicians was problematic, as patients with similar healthcare needs may not have been prioritized as equivalent. Due to the absence of a centralized booking system, various points of entry to hospital wait lists from public and private sectors were available, with different wait times possible for the same patient (Gauld and Derrett, 2000). Fraser et al. (1993) recommended the development of standardized priority
criteria, as well as a booking system to replace multiple wait lists. The New Zealand health care system made changes to their service delivery to incorporate the new guidelines for explicit priority criteria and a booking system that scheduled patients for surgery at the time of assessment (Fraser et al., 1993). Priority criteria were based on a patient’s need for treatment and their ability to benefit. The booking system was intended to provide comparable accessibility for patients of similar need, better wait times information and greater assurance of patients on service provision (Derrett et al., 2003).

**VII. Wait Times in Spain**

Spain became a decentralized country with the devolution of political power to 17 regions or Autonomous Communities with the Spanish Constitution of 1978 (Gaminde, 1999). The next change took place in health care with the enactment of the General Healthcare Law in 1986 and the inception of the Spanish National Health System, also known as the INSALUD (Gaminde, 1999; Rodriguez et al., 2000). The goal of the INSALUD was to ensure equity in access to comprehensive and universal health care for all Spanish citizens (Gaminde, 1999). In 2007, health expenditures accounted for 8.5 per cent of the GDP in Spain, which was slightly below the average of 8.9 per cent in OECD countries (OECD, 2009b). Public health care was mainly funded by general taxation that provided 72 per cent of the health budget in 2007 (OECD, 2009b). A private health sector exists to supplement services not covered by public health care (e.g. dentistry) and to bypass the public system by purchasing core health services (Rodriguez et al., 2000). In 2007, the private sector comprised 28 per cent of total health care expenditures in Spain, which was an increase from 1990 (21%) (OECD, 2009b; Rodriguez et al., 2000).
Similar to other publicly funded health systems, Spaniards experienced wait times in health care primarily in the specialties of orthopaedics, general surgery, ophthalmology, ENT surgery, urology and gynaecology (Moral and Pancorbo, 2001). The INSALUD developed initiatives from 1996 to 2000 to reduce wait times and improve access to treatment. An audit of surgical wait lists was undertaken by hospital admission departments in 1996 and resulted in the removal of 20 per cent of patients from wait lists (Moral and Pancorbo, 2001). Other initiatives were implemented such as financial incentives for additional productivity and referral to hospitals with available capacity (e.g. private or neighbouring INSALUD hospitals) (Moral and Pancorbo, 2001). Demand-side strategies in 1997 resulted in the development and implementation of centralized information systems for hospitals to register patients and to report monthly wait time data to the INSALUD (Moral and Pancorbo, 2001). Maximum wait time guarantees were established for 12 surgical procedures in 1997 by the INSALUD so that a patient had the right to obtain treatment elsewhere if they were waiting beyond the wait time guarantee (Gaminde, 1999). In 1996 and 1997, monthly financial incentives were associated with supply objectives but then transformed over time to funding in relation to monthly wait time targets. Hospitals that did not meet monthly targets in the number of patients waiting over 6 months (e.g. maximum wait time) and the mean wait time were given no extra funding (Moral and Pancorbo, 2001). Due to the initiatives since 1996, surgical productivity increased by 28 per cent from 1996 to 2000 with the reduction of mean wait times for elective surgery from 210 days in June 1996 to 67 days in December 2000 (Moral and Pancorbo, 2001; Siciliani and Hurst, 2005).

In 2007, Jovell et al. reported that over half of the Spanish population felt that fundamental changes were still needed with the health system (58%) and that government spending on
healthcare was inadequate (56%). Wait times for health care were viewed by 78 per cent of the population as the most important problem in the public sector (Jovell et al., 2007). A supply-side approach to improving wait times may not be effective since 86 per cent of the public did not support an increase in taxes to provide the additional funding to health care (Jovell et al., 2007). Therefore, another demand-side strategy such as the development of priority scoring systems may prove to be favourable with the public and further eliminate inefficiencies of the public health system.

VIII. Development of priority scoring systems

a. Point-count measures in prioritization

Point-count measures have been developed in countries such as New Zealand, Canada and Spain for the prioritization of elective surgical cases. Point-count systems are used worldwide in medicine and business due to their predictive accuracy. They are assumed to operate as statistical linear models (Hadorn et al., 2003). For example, the Apgar Score for neonatal assessment is a well-known clinical point-count system. This model uses five simple criteria (skin colour, heart rate, response to stimulation, muscle tone and respiration), each having three weighted levels (poor = 0 points, fair = 1 point, good = 2 points) (Apgar, 1953). A low Apgar score describes a newborn requiring immediate medical care (Hadorn et al., 2003). Similarly, priority scoring for elective treatment is similar to the Apgar Score with the use of symptoms and clinical findings to reflect the urgency for treatment of a medical condition. The priority score would be a weighted sum of all criteria that are used to prioritize patients in need of treatment. Each criterion would have different levels (e.g. degree of pain: none, mild, moderate, or severe) and each level would be assigned a different weight according to the relative significance of that level to the overall
priority score (e.g. heavier weight = severe pain = higher priority) (Hadorn et al., 2003). If the most heavily weighted level is selected across all criteria, the maximum priority score would result. In this case, a higher priority score would indicate a higher need for medical care.

b. New Zealand

Clinical priority assessment criteria, also known as CPAC, were developed in the five specialty areas of cataract surgery, coronary artery bypass graft surgery and angioplasty, hip and knee joint replacement, prostate surgery and hysterectomy (Gauld and Derrett, 2000). The CPAC is a point-count measure and screening tool to determine which patients receive access to elective surgery and to prioritize wait list cases (Derrett et al., 2003). A total CPAC score can range from 0 (lowest priority) to 100 (highest priority) and reflects the need of a patient for surgery and the capacity to benefit as determined at the time of assessment (Derrett et al., 2003). The New Zealand government intended to use CPAC as a guide in clinical decision-making and to ensure consistency of access across the nation (Dew et al., 2005; Gauld and Derrett, 2000).

A professional advisory group for each selected therapy, composed of specialists and general practitioners, selected priority criteria with the two-stage Delphi method (Hadorn and Holmes, 1997). The Delphi method is a formalized process of consensus in which experts rank their agreement to a statement in a questionnaire (e.g. relevant priority criteria for a specific procedure) over several rounds (Jones and Hunter, 1995). If panel agreement is not acceptable, another round of rankings will occur with the previous set of results available to the group (Jones and Hunter, 1995). The development of cataract and CABG (Coronary Artery Bypass Grafting) priority criteria was easier than the other elective areas due to the availability of evidence-based
literature and good agreement among committee members. For the three remaining groups, agreement was only achieved for the inclusion of social factors in the priority criteria (Gauld and Derrett, 2000). During a consultation project in mid 1994 by the CSC, several factors such as age, family and general health status, ability to work and current work status, time on a waiting list and limitations on activities were reported by the public to affect the need for elective treatment (Gauld and Derrett, 2000). An age formula was added to the CPAC for CABG patients over the age of 70 since the importance of life prolongation relative to quality of life was recognized by the advisory group to decrease with age (Hadorn and Holmes, 1997).

The CPAC form was completed for 97 cataract patients, 243 CABG patients and 69 hip/knee replacement patients by participating surgeons in a pilot study described by Hadorn and Holmes (1997). The patient need for surgery was also rated with a numerical score from 0 (no reasonable expectation of substantial benefit from surgery) to 100 (high level of expected benefit) for the cataract surgery and hip/knee replacement groups and “reasonable surgical wait times” (e.g. 21 days, 180 days) for the CABG group. Regression analysis was used to adjust priority criteria weights and simulated annealing algorithms accounted for the small data set and large number of criteria and levels used. The hip/knee CPAC accounted for 94 per cent of the variance observed in the patient need for surgery ($R^2 = 0.94$) (Hadorn and Holmes, 1997). After modification of the CPAC weighting scheme, the cataract $R^2$ improved from 0.49 to 0.70 and the CABG $R^2$ increased from 0.48 to 0.65 (Hadorn and Holmes, 1997). Age as a predictor variable in the regression did not significantly change the $R^2$ statistic, which indicated that the other criteria of the CABG CPAC was sufficient enough to account for age (Hadorn and Holmes, 1997). This pilot study concluded that the patient need for treatment could be predicted well by
CPAC for cataract surgery and hip/knee joint replacement. There were several limitations to this pilot study. The small number of patients in the study may have contributed to the inaccuracy of derived CPAC weights. Participating surgeons were not selected randomly and no statistical assessment was performed to determine differences between participating and non-participating surgeons. Lastly, surgeons ascertained the CPAC score prior to the numerical score that represented clinical judgment, which may have biased the latter results (Hadorn and Holmes, 1997).

The CPAC scoring system was used to define access to treatment or treatment thresholds by hospitals in accordance to available government funding (MacCormick et al., 2003b; McLeod et al., 2004). The CPAC score thresholds were unique to each hospital and region since they represented the demand for elective surgical services and available funds for particular institutions. A CPAC score above the financially sustainable threshold means the patient is of high need and treatment should be booked with a maximum wait time guarantee of six months. A patient who would benefit from surgery but with a CPAC score below the financially sustainable threshold was placed into clinical active review, thereby deferring their surgery. If a CPAC score was below the treatment threshold, access to the list for elective surgery was denied and the patient was referred back to their primary provider for continued care and reassessment (Gauld, 2004; McLeod et al., 2004). New Zealand funding levels were insufficient to treat the entire population and produced a discrepancy between the health operations purchased (financial threshold) and the recommended clinical cut-offs for elective surgery (clinical threshold) (Gauld et al., 2004; Gauld and Derrett, 2000). In an ideal situation, clinical thresholds should be set without financial constraints to ensure that priority scoring is an
objective process, based on clinical evidence and consistent within a hospital over time and among hospitals geographically (Dew et al., 2005). The HealthCare Otago booking system for cataract surgery set the treatment threshold at 38 points in 1996 despite that patients scoring 30 points or more have difficulties in driving and reading and require cataract surgery (Gauld and Derrett, 2000; HealthCare Otago et al., 1996). Fluctuations in funding caused this threshold to drop to 27 points, later increase to 30 points and increase again to 38 points in November 1998.

New Zealand health reforms were expected to reduce wait times. In May 1996, the government created the NZ $130 million in a Waiting Times Fund as a financial incentive for hospitals to implement the CPAC system and determine a threshold for access to treatment (Dennett et al., 1998; Gauld and Derrett, 2000). However the hasty implementation of CPAC in New Zealand led to a lack of national coordination in the development of standardized priority systems. Patients were not being prioritized similarly for the same procedure in different parts of New Zealand (Dew et al., 2005). Since 2005, New Zealand has continued to use a supply-side approach in improving wait times. Funding increases of $60 million per year in October 2006 and $160 million over five years in May 2008 were budgeted by the government to improve access to medical services (Cunliffe, 2008a, 2008b). Despite the continual investment of funds by the government, the problems with the CPAC and the booking system are still inherent. CPAC was not tested for reliability or validity. Lack of a centralized booking facility limited sharing of information about available capacity among clinicians and DHBs. Quality assurance measures were not employed to assess efficiency of resource utilization or the potential for abuse of the system.
c. Western Canada

The Western Canada Waiting List (WCWL) Project was a federally funded initiative created in 1999 to improve equity of access in Canadian health care with the development of standardized and validated priority scoring systems (Western Canada Waiting List Project, 2001). Priority scoring systems were intended to assess the relative urgency of a patient for treatment. The five areas of hip/knee joint replacement surgery, cataract surgery, general surgery, children’s mental healthcare and MRI were selected for this project due to the long wait times and public concerns related to these elective services (Noseworthy et al., 2003). Each service had its own panel comprised of specialists, family physicians, and representatives from health research and administration (Noseworthy et al., 2003). Each panel identified the relevant clinical (e.g. severity of the patient’s condition and potential to benefit from wait-listed services) and non-clinical criteria (e.g. ability to work, live independently or care for dependents) that best represented patient urgency for treatment (Western Canada Waiting List Project, 2001).

Priority criteria were based on suggestions from each panel and literature reviews in selected interventions (Noseworthy et al., 2003). Some panels chose to build upon existing priority criteria from other countries. The New Zealand priority scoring system served as the groundwork in the initial WCWL questionnaires for hip and knee joint replacement surgery, cataract surgery, general surgery and MRI (Arnett et al., 2003; Hadorn et al., 2002; Romanchuk et al., 2002; Taylor et al., 2002). In the WCWL cataract surgery group, the ‘New Zealand social factor’ (e.g. the ability to work, to care for dependents and to live independently) was split into three sections to assess the impact of each aspect separately (Romanchuk et al., 2002). The criterion that accounted for time spent waiting for treatment was initially considered in the WCWL studies.
Patients with relatively minor, benign, but significant conditions such as cataracts or hernias will always score lower than the symptomatic and severe cases. A concern was that lower scoring patients would continue to be pushed to the end of the wait list and not receive timely treatment. However if time spent waiting was included in the priority scoring, minor cases could “bump” severe cases on a regular basis. Therefore in the end, the time spent waiting factor was not included in the WCWL prioritization. Lyons and Shaw (2002) suggested that mandatory reassessments of patient eligibility could counteract the time spent waiting for minor cases and be a quality assurance measure for patients and the wait list.

Each panel followed a similar framework in priority criteria development. All diagnoses and treatments were included in the areas of general surgery, MRI and children’s mental health, whereas in the therapies of cataract surgery and hip & knee joint replacement, case types and interventions were specific (Noseworthy et al., 2003). Each WCWL priority criterion had levels that corresponded to severity (none, mild, moderate, severe), frequency (none, occasional, often, constant) or probability (low, medium, high), which were then paired with numerical weights for the initial stages of testing. The priority criteria score (PCS) is the point-count measure in WCWL studies and represents a weighted sum of the relevant priority criteria. The maximum PCS is 100 points if the severe category is selected across each of the criteria (Taylor et al., 2002). In this case, a higher PCS would indicate a higher level of urgency for treatment. In the initial testing of the WCWL scoring systems, clinicians rated the patient urgency for treatment on a 100 mm visual analogue scale (VAS) that ranged from 0 (not at all urgent) to 100 (extremely urgent or just short of an emergency) (Noseworthy et al., 2003). The initial weights for the criteria levels were determined by regression analysis with the physician-rated VAS as
the dependent variable (Noseworthy et al., 2003). Case types with varying levels of need for
treatment were identified and given a corresponding access target (Sanmartin, 2001). Unlike the
New Zealand CPAC, the WCWL project members planned the testing of priority scoring
systems for validity and reliability prior to implementation in Canada (Western Canada Waiting
List Project, 2001).

i. WCWL Hip and Knee Joint Replacement

The WCWL hip and knee joint replacement panel consisted of seven academic and community
orthopedic surgeons, three family physicians, a geriatrician, a physical therapist and a
rheumatologist that met periodically from October 1999 to June 2000 (Arnett et al., 2003). The
hip/knee priority scoring system was applied to 405 patients in the clinical practices of nine
panel members and eight associated colleagues, starting December 1999 (Arnett et al., 2003).
Revisions were made to the priority criteria in January 2000 that included the addition of the
item, “potential for progression of disease”. This criterion accounted for patients who needed
surgical revision on their previous joint replacements who often scored low on pain or functional
disability but were considered urgent since optimal treatment outcomes were time dependent.
The revised hip/knee priority scoring system consisted of seven criteria that determined the
patient need for joint replacement surgery. Regression analysis revealed that about two-thirds of
the statistical variance in the VAS urgency ratings was due to the hip/knee scoring system ($R^2 = 0.68$; adjusted $R^2 = 0.68$). With the removal of revision patients, adjusted $R^2$ statistic increased to
0.71. The most powerful predictors of surgical urgency were the combined item of pain at
motion and at rest, potential for progression and the ability to work or look after dependents.
ii. WCWL Cataract Surgery

The WCWL Cataract Surgery panel was established in October 1999 and composed of seven academic and community ophthalmologists, two family physicians, an optometrist, a health care services investigator and a health information specialist (Romanchuk et al., 2002). Pilot testing of the initial criteria was conducted on 563 patients from November 1999 to May 2000 (Romanchuk et al., 2002). About one-third of the statistical variance in the VAS urgency ratings was due to the cataract priority scoring system ($R^2 = 0.31$; adjusted $R^2 = 0.30$). Visual function was the most influential predictor of urgency with a 23-point weight for the most severe level of impairment. The three social factors (ability to work, to live independently and to care for dependants) from the New Zealand criteria were merged into a single factor and given a heavier weight. The criterion of coexisting ocular disease was also given more specific descriptors and weights. The final cataract priority scoring system had seven priority criteria (Conner-Spady et al., 2005b).

iii. WCWL General Surgery

The WCWL General Surgery panel included seven academic and community general surgeons, two family physicians and members from health research and administration (Taylor et al., 2002). Due to the comprehensive range of conditions and procedures managed by general surgeons, the WCWL general surgery panel decided that procedures completed in the operating room would fall under adult general surgery and its priority criteria would represent the broad nature of this specialty. From November 1999 to May 2000, pilot testing of the general surgery priority scoring system was carried out on 561 patients by 13 surgeons from Western Canada. Approximately two-thirds of the statistical variance in VAS urgency ratings was explained by
the general surgery priority scoring system \( (R^2 = 0.64) \) (Taylor et al., 2002). The panel had initially planned to create two sets of priority criteria for non-cancer and cancer patients with life expectancy items (e.g. life expectancy implications of the condition without the procedure; expected improvement in life expectancy with surgery) restricted to the latter group. However in the final assessment, the same priority criteria were applied to all patients since in clinical practice, general surgeons commonly treated both groups of patients within the same limited block of operating room time. Consequently, the patients were often compared together to prioritize for finite surgical resources.

**iv. WCWL Children’s Mental Health Services**

The WCWL Children’s Mental Health (CMH) panel was established in October 1999 and consisted of three child and adolescent psychiatrists, a general psychiatrist, a family physician, two psychologists, a pediatrician, two mental health administrators, a social worker and health services researcher (Smith et al., 2002). The panel of CMH experts selected 17 priority criteria to form the CMH PCS that measured the severity of the mental condition, social factors and the potential to benefit from treatment. A VAS and the maximum acceptable wait time (MAWT) items were added to the PCS to determine the physician’s rating of patient urgency for treatment and the maximum length of time a patient should wait. Panelists and designated colleagues rated 92 consecutive patients with the CMH priority scoring system in their clinical practice from November 1999 to May 2000 (Smith et al., 2002). About 40 per cent of the statistical variance in the clinician-rated VAS was a result of the CMH priority scoring system \( (R^2 = 0.42; \text{adjusted } R^2 = 0.40) \). When the model was separated into the different rater groups, the priority criteria explained only 40 per cent of the observed variation in the VAS by psychiatrists \( (R^2 = 0.40) \) and
50 per cent of the observed variation in the VAS by non-psychiatrists ($R^2 = 0.51$) (Smith et al., 2002). In addition, the estimated weights for CMH priority criteria items were comparable for psychiatrists and non-psychiatrists. The heavily weighted scores were found with the items of internalized symptoms (e.g. depression, anxiety, worry, grief, unhappiness), degree of likely benefit from treatment and Children’s Global Assessment of Functioning scale (Smith et al., 2002).

v. WCWL Magnetic Resonance Imaging

The MRI panel of seven academic and community radiologists, a family physician, a neurologist, a paediatric neurologist, an orthopedic surgeon, a neurosurgeon and two health administrators worked together from October 1999 to June 2000 (Hadorn et al., 2002). Fifteen specialists used the MRI priority scoring system to prioritize 407 patients during the period of November 1999 to May 2000 (Hadorn et al., 2002). Most of the testing was undertaken by referring specialists, as they were considered to be more knowledgeable about the patients and clinical situations. The MRI priority scoring system accounted for 40 per cent of the statistical variance seen in the VAS urgency ratings ($R^2 = 0.40$). The most heavily weighted items were “probable time course for clinical deterioration” and “probability that successful intervention would result from MRI information”. In the final assessment, 60 per cent of the maximum score was distributed among diagnostic value, natural history and probable success of treatment, whereas the remaining 40 per cent was allocated for items pertaining to current symptom status.

The MRI priority scoring system was more difficult to develop due to the extensive range of patient types requiring this service and the nature of diagnostic procedures. Certain conditions
diagnosed through MRI do not have definitive treatments such as multiple sclerosis and malignant brain tumours (Hadorn et al., 2002). The potential to benefit from MRI in these cases is difficult to measure. The access to MRI for these special cases was understood as important by the panel however consensus on the level of urgency for these patients was complicated and unlike other clinical areas. Half of the original MRI priority criteria (5 of 10) required probability judgments on findings that are often unknown before the MRI such as the severity of a patient’s condition, the likelihood of its deterioration and if the information from the MRI would alter treatment and success of subsequent treatment. Therefore, the scoring of probability-based criteria was difficult and varied among clinicians. The removal of these probability criteria would not reflect the true nature of prioritization and the likely benefit of MRI and were therefore included in the revised MRI priority scoring system.

d. Spain

The use of preliminary priority criteria was instituted in 1996 but prioritization was based on implicit clinical judgment and the length of time already waited by patients. Subsequently, the INSALUD and medical experts developed guidelines for surgical indications and patient prioritization (Moral and Pancorbo, 2001). Several independent groups in Spain have also developed priority scoring systems for cataract surgery and hip and knee joint replacement surgery (Allepuz et al., 2008; Escobar et al., 2007, 2009).

In Catalonia, the Catalan Agency for Health Technology Assessment and Research developed priority scoring instruments for hip and knee arthroplasty and cataract surgery by conjoint analysis that included the general population (group 1), patients and close relatives (group 2),
allied-health professionals (e.g. general practitioners, nurses, social workers, optometrists, physiotherapists; group 3) and consultants (e.g. orthopedic surgeons, rheumatologists, rehabilitators, general practitioners; group 4) (Sampietro-Colom et al., 2008). The groups were organized in this manner to reflect different roles and perspectives on health care.

The identification and selection of priority criteria was completed in 2000 by the four focus groups of about 5 to 10 individuals each. A nominal group technique was used to rank the importance of the priority criteria from 1 (least important) to 9 (most important) (Sampietro-Colom et al., 2009). The nominal group technique is similar to the Delphi method in that consensus by relevant experts is measured through a series of structured rounds. However the former consensus method uses a moderator and observer during rounds and structured face-to-face meetings are conducted rather than self-administered questionnaires, correspondence by mail or computer (Jones and Hunter, 1995). The mean scores of the priority criteria were ranked on a list for each focus group. The criteria with the highest mean scores identified by the most groups were selected. Levels were assigned to each criterion by the research team and combinations of priority criteria with varying levels were generated to outline the case mix encountered in clinical practice. Seven criteria, each with two or three levels, were selected by the arthroplasty group (Sampietro-Colom et al., 2008) and six criteria, each with two or four levels, were selected by the cataract group (Sampietro-Colom et al., 2006). The criteria were composed of clinical (e.g. disease severity, pain and recovery probability, visual impairment) and social factors (e.g. difficulty performing activities of daily living, limitation on the ability to work, having a caregiver and being a caregiver) (Sampietro-Colom et al., 2008). A total of 288
case scenarios were generated for both elective areas and then limited to 16 case scenarios for ranking.

New participants for each focus group (arthroplasty group: n = 860; cataract group: n = 771) were selected by randomization techniques (e.g. multistage probability sampling, quota sampling) for the ranking of case scenarios and the seven priority criteria in each scenario (Sampietro-Colom et al., 2006, 2008). The weights for criteria levels were calculated using a regression method with priority criteria as the independent variables and the participant-ranked scenarios as the dependent variables (Allepuz et al., 2008; Sampietro-Colom et al., 2008). The overall priority score for a case scenario was the summation of all weights for each criterion and ranged from 0 to 100. The case scenario with the highest surgical priority scored 100 points.

The priority criterion rated as most important was pain (33/100) in the arthroplasty group and visual impairment (45/100) in the cataract group. The probability of recovery was rated the lowest in importance in both groups (arthroplasty group: 4/100; cataract group: 7/100) (Sampietro-Colom et al., 2006, 2008). In the arthroplasty study, a higher weight was given to the pain criterion and less weight was assigned to the performance of ADL by patients and their relatives possibly due to previous disease experience (Sampietro-Colom et al., 2008). The correlation of ranked patient scenarios was the highest between allied-health professionals and consultants ($\rho = 0.97$) and the lowest between consultants and the general population ($\rho = 0.77$) (Sampietro-Colom et al., 2008). In the cataract study, the public, patients and their relatives assigned a higher weight to visual impairment and less weight to the performance of ADL (Sampietro-Colom et al., 2006). Although priority scoring patterns of case scenarios were
similar, the estimated weighting scheme differed among the four groups such that the final order of cataract surgery cases on the wait list could differ by up to 27 positions (Sampietro-Colom et al., 2006). A limitation of these studies was the small number of health professionals that participated (arthroplasty consultants: n = 97; cataract allied-health professionals: n = 85, consultants: n = 79) in relation to other groups. Power analysis revealed that a minimum of 279 participants was needed per group (type I error = 0.05) (Sampietro-Colom et al., 2006, 2008).

Other groups in Spain developed explicit priority criteria for patients waiting for total joint replacement (Escobar et al., 2007; Quintana et al., 2000) and cataract surgery (Quintana et al., 2006a, b) by a modified Delphi method (Brook et al., 1986). A comprehensive literature review was conducted on the benefits, risks and costs of the selected intervention to compile a list of mutually exclusive clinical scenarios or indications for a particular therapy. The research team recorded 216 clinical scenarios for total hip joint replacement (THJR) surgery with six priority criteria and associated levels (Quintana et al., 2000) and 765 clinical scenarios for cataract surgery with five to six priority criteria and associated levels (Quintana et al., 2006a, b). The scenarios for cataract surgery were also grouped into three diagnostic subgroups of simple cataract, cataract with diabetic retinopathy and cataract with other ocular pathologies (Quintana et al., 2006a). In Escobar et al. (2007), 192 clinical scenarios for total joint replacement (TJR) with seven priority criteria and associated levels were derived from a review of the literature, suggestions from the research team (2 orthopaedic surgeons, 2 clinical epidemiologists) and focus group discussions with wait list patients.
Expert panels were created for each intervention and to rate the clinical scenario for the appropriateness of the intervention (Quintana et al., 2000: 9 orthopaedic surgeons; Quintana et al., 2006a: 12 ophthalmologists). The appropriateness of the intervention was defined as the expected benefits of the procedure sufficiently exceeded the expected risks so that the intervention was worthwhile (Quintana et al., 2000, 2006a, 2006b). This appropriateness factor was a new concept that was not considered in the New Zealand and Western Canada studies for priority criteria development. The rating sessions took place in two rounds using a modified Delphi method. A 9-point scale was used for rating clinical scenarios. In Quintana et al. (2000, 2006a), the intervention for a clinical scenario was considered inappropriate if the median panel score (MPS) was between 1-3 and without disagreement, uncertain if MPS was between 4-6 or if there was disagreement among panel members and appropriate if MPS was between 7-9 and without disagreement. Agreement was achieved if less than one third of the panel rated outside the 3-point region that contained the MPS for the scenario (Quintana et al., 2000, 2006a). Disagreement was evident when a minimum of one third of panelists rated from 1-3 and a minimum of another third of panelists rated from 7-9 for the scenario (Quintana et al., 2000, 2006a). All other situations were considered indeterminate for agreement or disagreement. The inter-rater reliability of the appropriateness scores of the 12 panelists was good (ICC = 0.69) in the second round (Quintana et al., 2006a). The criteria of preoperative visual acuity in the operated eye and patient-rated visual function best explained the scoring by the panel members (Quintana et al., 2006a).

A similar methodology was used in Escobar et al. (2007) with the development of explicit criteria for TJR. A total of 192 scenarios were rated on priority (low, intermediate, high) for TJR
based on the expected benefit. Pain on motion (24 points) and walking functional limitations (19 points) were the variables that were the most influential to the priority scores. The inter-rater reliability of 12 panelists on the scoring of 192 scenarios was good for both rounds (e.g. Round 1 ICC = 0.56; Round 2 ICC = 0.72) (Escobar et al., 2007).

A third round of the modified Delphi method was conducted in Quintana et al. (2000) for appropriate scenarios (n = 68) from the second round for THJR. Pain level and functional limitations were the most influential variables in the panel scoring on appropriateness for THJR (Quintana et al., 2000). A similar third round was conducted in Quintana et al. (2006b) for scoring the appropriate and uncertain scenarios for cataract surgery (n = 310) from the second round in Quintana et al. (2006a). Another 9-point scale was used in the third round that was separated into three 3-point regions that described case priority as low (MPS = 1-3 and without disagreement), intermediate (MPS = 4-6 or disagreement) and urgent (MPS = 7-9 and without disagreement). The weighting of priority criteria levels was completed by regression methods of optimal scaling similar to the WCWL studies and a general linear model. There was high correlation with the priority scores of the panel for scenarios and the optimal scaling method (Pearson’s $r = 0.95$) and with the general linear model (Pearson’s $r = 0.97$). The appropriateness of the intervention factor was highly significant ($p < 0.05$) in its contribution to the priority score and had the fourth heaviest weight in priority scoring in both regression models.

Spain has only recently begun to investigate the use of explicit criteria and point-count measures for the prioritization of patients on elective surgery wait lists. The studies of Allepuz et al. (2008)
and Escobar et al. (2009) will be discussed later with regard to the reliability of the priority scoring systems.

e. Summary

New Zealand was a forerunner in the development of priority scoring systems and its implementation in public health care by the late 1990s. CPAC was designed to screen which patients would receive elective treatment and finances rather than clinical evidence dictated treatment thresholds. Due to lack of testing and organization, CPAC was invalidated and inconsistent among hospitals and jurisdictions across New Zealand. Subsequently Western Canada and Spain created priority point-count measures for ranking patients on wait lists and unlike New Zealand, validity and reliability testing of priority criteria has been undertaken. Most of the priority scoring systems were developed in a systematic manner that utilized literature reviews and differed in stakeholder involvement. Sampietro-Colom et al. (2006, 2008) in Spain was one of the few groups that applied conjoint analysis from the beginning with priority criteria selection to the end with weighting of levels for each criterion. Similar patterns were observed in priority scoring for case scenarios but different estimated criteria weights resulted between stakeholder groups (Sampietro-Colom et al., 2006, 2008). The discrepancy in weighting may impact the wait list position and wait time of a patient depending upon which stakeholder group scored the patient. Health care professionals have the clinical expertise to determine the level of need for elective surgery but patients are the ones that experience the burden of waiting. Members of the public may provide another perspective on prioritization since they finance the health care system and are potential patients. The participation of all
stakeholders in the creation of priority scoring systems may ensure comprehensiveness, transparency and trust in the process.

Despite the differences in development, priority criteria selection and relative weighting were similar for hip and knee joint replacement and cataract surgery for all three countries. Pain was scored as the most important priority criterion in the hip and knee joint replacement studies reviewed (Arnett *et al.*, 2003; Escobar *et al.*, 2007; Hadorn and Holmes, 1997; Quintana *et al.*, 2000; Sampietro-Colom *et al.*, 2008). In cataract studies, visual acuity was scored as the most important factor in prioritization (Hadorn and Holmes, 1997; Romanchuk *et al.*, 2002; Sampietro-Colom *et al.*, 2006). The estimated weights in priority scoring systems are difficult to quantitatively compare since the criteria and corresponding levels differ between studies for the same elective therapy. The social factors in hip and knee studies (e.g. ability to provide care to dependents, to work or to live independently) varied in its weighting from 10 to 20 per cent of the priority scoring system, except in Quintana *et al.* (2000) where social factors were not considered as surgical indications for total joint replacement.

The explanatory power of the priority scoring system was reported with the coefficient of determination ($R^2$ statistic) in the WCWL, New Zealand and Escobar *et al.* (2007) studies but could not be compared since the $R^2$ statistic is sensitive to the number of predictor variables in the regression and sample sizes. Only three studies (WCWL hip/knee replacement, cataract surgery, CMH) used the adjusted $R^2$ statistic that accounted for any irrelevant criteria introduced to the model.
IX. Reliability

Reliability is the extent to which an instrument can produce consistent measurements (Brunette, 1996; Streiner and Norman, 1998). Priority scoring systems were tested for reliability in studies to evaluate consistency in assessing patient urgency for treatment among clinicians, temporally and geographically.

a. WCWL reliability studies

Six standardized cases of differing urgency were developed for reliability testing of each of the WCWL priority scoring systems (Noseworthy et al., 2003). The test cases represented real-life clinical situations and were not developed to have an exact fit with the priority criteria and its levels. The general surgery and cataract surgery groups viewed simulated cases with patient-actors on videotape, while the hip and knee replacement panel viewed videotapes of real patient assessments. The MRI and children’s mental health panels used a series of hypothetical paper cases. Inter-rater reliability was mainly evaluated by the interclass correlation coefficients (ICC) for each priority criterion and the VAS. After the first phase of reliability testing, the priority criteria were reviewed and revised to enhance inter and intra-rater reliability. The WCWL panels also collectively discussed the ratings of two of the six cases for a more thorough appraisal of the priority criteria. The same six cases were retested but the order of case presentation was modified to control for order effects.

i. Hip and Knee Joint Replacement

In June 2000, the hip/knee priority criteria had fair to excellent inter-rater agreement (range of ICC values = 0.63 to 0.83) (Arnett et al., 2003). Similar results were seen between the entire
group of physicians (n = 19) and a subset of orthopedic surgeons (n = 14). Similar reliability results were observed in December 2000. However one item (e.g. potential for progression of disease) showed poor inter-rater reliability in June 2000 (ICC = 0.38 all raters; 0.47 for orthopedic surgeons) and December 2000 (ICC = 0.25). The potential for disease progression is a criterion based on probability, which can account for some of the inconsistency between the groups. Good to excellent intra-rater reliability (range of ICC values = 0.60 to 0.86) was reported with the priority criteria over the 6-month interval. General practitioners (n = 11) were reported to show comparable reliability values to orthopedic surgeons, except on the item of “ability to walk without significant pain”, however these findings could not be confirmed from the data presented. The VAS ratings had excellent inter-rater reliability (ICC = 0.82 all raters; 0.85 for orthopedic surgeons) and excellent intra-rater reliability of ICC = 0.90 (Arnett et al., 2003).

ii. Cataract Surgery

In June 2000, Romanchuk et al. (2002) reported excellent inter-rater reliability for most cataract priority criteria items (range of ICC values = 0.85 to 1.00). Items related to glare (ICC = 0.15) and ability to work/live independently/care for dependants (ICC = 0.04) showed poor agreement. The reliability of priority criteria over a 6-month period was good to excellent (range of ICC values = 0.65 to 1.0) but was poor for glare and social factors (ICC < 0.30). The VAS ratings by clinicians (n = 11) had poor agreement (ICC = 0.25) and a slightly higher agreement (ICC = 0.44) resulted if ophthalmologists (n = 8) were considered separately. Fair to good intra-rater reliability was observed for VAS ratings of patient urgency (ICC = 0.65 all raters; 0.74 for ophthalmologists) (Romanchuk et al., 2002)
iii. General Surgery

The revised general surgery priority criteria had excellent agreement among 12 raters for three criteria (range of ICC values = 0.77 to 0.86) and fair to good agreement for three other criteria (range of ICC values = 0.56 to 0.70) (Taylor et al., 2002). Good to excellent intra-rater agreement over the 2-month interval was found for three revised priority items (range of ICC values = 0.67 to 0.89). Excellent inter-rater (ICC = 0.83) and intra-rater reliability (ICC = 0.92) over the 2-month interval was found for VAS ratings (Taylor et al., 2002).

Poor inter-rater reliability (k = 0.34) and intra-rater reliability (k = 0.33) was reported for one priority criterion (Taylor et al., 2002). The item of “recent history of major complications or significant examination/test results” may represent two conflicting ideas and explain the low agreement among raters. The recent history of major complications may decrease the level of urgency for treatment since the surgical risks exceed the benefits for the patient. However the recent history of significant examination or test results may further increase the need for surgery of a patient with the delivery of new information. Thus, the low reliability of this criterion may be explained by its dual meanings. Further revision of the general surgical priority criteria is needed before implementation.

iv. Children’s Mental Health Services

From the 17 revised priority criteria, ten items had fair to excellent inter-rater reliability (range of ICC values = 0.66 to 0.87), while seven items showed poor agreement (range of ICC values = 0.14 to 0.46) among 21 mental health professionals (Smith et al., 2002). “Global age-appropriate development” (ICC = 0.14), “family functioning” (ICC = 0.22), and “degree of likely benefit”
(ICC = 0.24) gave the lowest agreements (Smith et al., 2002). Intra-rater reliability was evident in 13 raters with 11 revised items of excellent agreement (range of ICC values = 0.77 to 0.91) and six revised items of fair to good agreement (range of ICC values = 0.46 to 0.69) over a 2-month interval (Smith et al., 2002). Excellent inter-rater reliability (ICC = 0.80) and intra-rater agreement (ICC = 0.85) was found for VAS ratings (Smith et al., 2002).

v. Magnetic Resonance Imaging

The criteria item of “usual duration, frequency, intensity of pain and/or suffering” showed fair to good agreement (ICC = 0.60) among orthopaedic surgeons, neurosurgeons and neurologists since the item was easy to measure. Poor agreement was detected for the remaining four MRI items (range of ICC values = 0 to 0.38) (Hadorn et al., 2002) with three items based on probability judgments. The VAS ratings had poor inter-rater reliability (ICC = 0.38) (Hadorn et al., 2002). Over two months, good intra-rater reliability was reported for MRI priority criteria (range of ICC values = 0.50 to 0.76) and VAS urgency ratings (ICC = 0.68) (Hadorn et al., 2002).

b. International reliability studies

i. New Zealand

Few studies tested the CPAC for reliability prior to its implementation in New Zealand. Halliwell (1998) tested the consistency of scoring using two different prioritization tools, Old form and New form, for cataract surgery. Two experienced members of the nursing staff independently evaluated 39 patients awaiting cataract surgery at the Wellington Hospital. The cataract CPAC scores for the Old form and the New form varied between the two examiners for
majority of the patients. The CPAC scores of the examiners coincided in 12.8 per cent patients using the Old form and 7.7 per cent patients using the New form. The range of scores between examiners for individual patients was as much as 22 points using the Old form and as much as 26 points using the New form. The results showed that a patient could have a 90 per cent chance of receiving different CPAC scores, separated by as much as 26 points, from two examiners. Lack of consistency was revealed in this study and showed the cataract CPAC to be an unacceptable prioritization tool.

The limitations of the study were related to the methodology and analysis of the results. Nurses performed clinical assessments and scored the cataract patients. Nurses were selected as the raters to minimize the potential ‘gaming of the system’ by self-interested surgeons (Halliwell, 1998). Although the nurses were experienced, they were not capable of making definitive recommendations as to whether or not patients required cataract surgery. Examination and rating by an ophthalmologist may have improved CPAC scores of measuring visual impairment and the patient’s need for surgery. There was a lack of consistency in the participating examiners. The first examiner, labeled as the chief examiner, was the same nurse throughout the study but the second examiner position was shared between two nurses. The analysis did not separate the CPAC scores between the two different nurses for the second examiner position but instead assumed that all scores were from the same examiner. Assessments of reliability could have been improved with the use of statistical measures of inter and intra-rater reliability.

**ii. Spain**

Allepuz et al. (2008) tested reliability of the AI and CI priority instruments on a set of 21
hypothetical cases (11 hip and knee arthroplasty, 10 cataract surgery) based on clinical patient histories of those waiting for surgery. ICC was calculated to determine inter-rater reliability where an ICC of 0.7 or higher was deemed acceptable for group comparisons and 0.9 or higher for individual comparisons. For the hip and knee arthroplasty group, 16 doctors were involved with 14 to 15 scores for each scenario and the inter-rater reliability was in excellent agreement (ICC = 0.79, CI 95%: 0.64-0.94) for the AI (Allepuz et al., 2008). The cataract surgery group consisted of 49 participants with 29 to 33 assessments for each scenario and a similar inter-rater reliability of the AI was seen for the CI (ICC = 0.79, CI 95%: 0.63-0.95) (Allepuz et al., 2008). Quintana et al. (2000) reported high intra-rater reliability (weighted kappa = 0.81, CI 95%: 0.68, 0.95) of the main panel of orthopaedic surgeons (n = 9) for 45 THJR cases over one year. A new panel of orthopaedic surgeons (n = 9) was created to compare the inter-rater reliability of the main panel by scoring 216 case scenarios with the THJR priority scoring system. A good agreement was observed between the two panels (weighted kappa = 0.77, CI 95%: 0.71, 0.83). In addition, a total of 45 selected case scenarios were scored by 107 orthopaedic surgeons from neighbouring public hospitals and was in excellent agreement with the main panel scores (weighted kappa = 0.89, CI 95%: 0.8, 0.99).

c. Summary

The priority scoring systems for hip and knee joint replacement and cataract surgery have shown the highest reliability amongst Canadian and Spanish studies (Allepuz et al., 2008; Arnett et al., 2003; Romanchuk et al., 2002; Quintana et al., 2000). Priority criteria for general surgery and children’s mental healthcare in the WCWL project had good to excellent reliability. High reliability scores suggested the clarity and stability of these priority scoring systems amongst a
variety of professionals and over time.

The WCWL MRI group had the lowest inter-rater agreement. Criteria that rated patients for prediction of future benefit from intervention or clinical progression of disease demonstrated low reliability. Social factors from the WCWL cataract priority scoring system demonstrated lower inter-rater reliability (ICC = 0.04) (Romanchuk et al., 2002) than social factors (e.g. being a caregiver) in the CI (ICC = 0.79) (Allepuz et al., 2008). However these two studies were difficult to compare since the priority criteria were analyzed for reliability individually in Romanchuk et al. (2002) and as a whole in Allepuz et al. (2008). Intra-rater agreement was not evaluated in Allepuz et al. (2008). Revision of the WCWL tools was planned for further testing and validation before the implementation into clinical practice. Halliwell (1998) was one of the few studies that investigated the reliability of CPAC and applied reliability testing in clinical practice. However due to the lack of statistical analysis (e.g. ICC, kappa statistics), comparisons with other reliability studies are limited.

The VAS is a simple, easy to use and clinically efficient measure and demonstrated excellent reliability in the prioritization of patients for hip and knee joint replacement, general surgery and children’s mental health between raters and over time (Arnett et al., 2003; Smith et al., 2002; Taylor et al., 2002). However the VAS is not as objective and explicit when compared to priority scoring systems, which may explain the poor inter-rater agreement of VAS ratings observed in the WCWL cataract surgery and MRI groups (Hadorn et al., 2002; Romanchuk et al., 2002).
X. Access targets

An access target is the maximum acceptable wait time that an elective procedure can be delayed until the potential to benefit from treatment is adversely affected. The assignment of access targets to priority levels for an elective procedure is another demand-side strategy for wait list management. In theory, patients with urgent need for care should be treated before cases with minor impairment that can afford to wait. Patients with the same medical condition and comparable levels of urgency should have similar wait times for treatment. Ideally, actual wait times would not exceed the access target for treatment.

Several factors have been considered in the development of access targets. Oudhoff et al. (2007) reported that maximum acceptable wait times ranged from 2 and 25 weeks for elective general surgery and varied according to the type of condition (p < 0.001) and the severity of the patients’ symptoms (p < 0.001). Other factors such as the effects of waiting on patient health and treatment outcomes, costs of delayed treatment and acceptability of wait time targets to all stakeholders may influence access targets (Conner-Spady et al., 2004; Conner-Spady et al., 2005a; Sanmartin, 2001; Sanmartin et al., 2007). Access targets must also be sustainable in the context of finite and often variable resources.

The aim of access targets is to provide transparency in the wait list system so that patients and physicians are aware of the maximum acceptable wait times corresponding to level of need for elective treatment. If standard wait times for treatment are set, the uncertainty of waiting is lessened for patients. Naumann et al. (2001) reported that patients who were notified of their expected wait time during triage reported higher levels of satisfaction and increased perception
of fairness in the system. If a local physician cannot provide treatment within the access targets, patients can seek treatment elsewhere. However, Hanning (1996) reported that 90 per cent of patients chose to wait longer for cataract surgery rather than switching providers with shorter wait lists. Anderson et al. (1997) found that only 15 per cent of Canadians were willing to pay for shorter wait times in cataract surgery. Physicians, hospitals and the government can be held accountable for the wait list system by allowing comparison of actual wait times and access targets. The 2006 Fraser Institute report stated that 77 per cent of actual wait times for all 10 provinces and 13 specialties in Canada surpassed the clinically reasonable wait times set by specialists (Esmail and Walker, 2007).

Access targets may differ according to the stakeholder groups (patients, public, clinicians, government) involved in their development (Sanmartin, 2001). Patients are the consumers and recipients of public health care. Patients experience the true effect of waiting by living with their illness or disability until care is delivered. They are the most likely beneficiaries of appropriate access targets. The WCWL project organized public opinion focus group sessions to assess the public’s views on the current wait list system and its management (McGurran et al., 2002). About 60 per cent of the participants in the study had direct or indirect experience (e.g. immediate family member) with waiting for elective treatment (McGurran et al., 2002). The findings of the study revealed that the public wants and expects to be consulted in health policy development and implementation. McGurran et al. (2002) concluded that “public involvement is not an option for moving forward; it is a necessity”. With Canadian health care being funded by taxpaying citizens, the public’s expectation to participate in significant health care decisions is warranted. The acceptability of access targets to patients may be related to an individual’s
expectation of what is an appropriate wait time for treatment. Conner-Spady et al. (2004) found patients with wait times for cataract surgery that were shorter than their patient-rated access target had significantly greater odds of being satisfied with their wait time (adjusted OR 3.86, 95% CI: 1.38-10.74) than those with longer wait times.

The physician has the knowledge and clinical expertise to formulate empirically based wait times for patients with differing levels of urgency. Case based scenarios and physician surveys have mainly been used in the literature to determine the appropriateness of access targets. In a prospective cohort study, Conner-Spady et al. (2005c) surveyed patients and physicians on their perspectives of MAWTs for cataract surgery. Physician-rated MAWTs (mean = 15.05 ± 7.94 weeks) were significantly longer than patient-rated MAWTs (mean = 9.87 ± 7.81 weeks) and more comparable to actual wait times (mean = 17.00 ± 11.52 weeks) for cataract surgery. The perspectives of physicians and patients may differ due to their roles in the wait list system – surgeons are administering the access targets and patients are experiencing them. When MAWTs were correlated with urgency levels assessed by the cataract PCS, both patients and physicians agreed that the most urgent patients required the shortest MAWTs (Conner-Spady et al., 2005c). In contrast, Oudhoff et al. (2007) found no significant differences in the perceived MAWTs for elective general surgery by patients and physicians in the Netherlands (p = 0.281). However, variability was reported in the types of responses found within each group and was dependent on the opinions of wait list acceptability in health care. The Fraser Institute conducted a Canadian national survey for physicians with regard to their assessment of acceptable waits for procedures ranging from ophthalmology, orthopedic surgery and general surgery (Zelder and Wilson, 2000). In 1999, estimated access targets for cataract removal were as low as 6.0 weeks in Nova Scotia,
British Columbia and Alberta and as high as 12.0 weeks in PEI and Saskatchewan (Zelder and Wilson, 2000). These results revealed differences amongst physicians in determining wait times for elective procedures such as cataract removal. The inconsistencies in physician-rated access targets may be related to non-clinical factors such as regional differences of supply and demand for certain procedures across Canada. Physicians are the most capable to interpret the limited research literature in regards to access targets and in combination with clinical expertise, physicians are the most qualified to judge the maximum length of time a patient can safely wait for treatment.

Lastly, the government perspective on wait times involves a group of stakeholders who are not driven by the same motives as the patient or the clinician. The economic CPAC thresholds for treatment represent the New Zealand government’s emphasis on financial concerns rather than scientific evidence. To achieve face validity of access targets, inclusion of input from all stakeholders may be required. Lack of evidence on the relationship of treatment outcomes and the timeliness of care for elective treatment necessitates the use of consensus-based methods in access target development (Paterson et al., 2006). The next steps will be to test access targets for predictive validity with clinical outcomes as was done for prioritization systems.

XI. Public Reporting of Wait Lists in Canada

Prior to 2004, wait times information was not readily available at the hospital or provincial level in Canada. Hospitals, provincial governments and the public did not know the wait times for particular medical services and the number of patients who were waiting for treatment. Surgeons independently coordinated queues for treatment in their private clinics. There was no exchange
of wait list information among medical colleagues so patients could not switch their care to a
doctor with a shorter wait time. However in recent years, provinces have made efforts to collect
and publicize information about wait times for surgery by type of service, region, facility and
surgeon on publicly accessible websites.

The Wait Time Alliance (2009) identified Ontario as one of the provinces that had made
significant progress on public reporting of wait times by increasing the range and frequency of
surgical procedures reported. The Wait Times Information System (WTIS) in Ontario was
deployed in 2005 and was based on the information infrastructure developed by Cancer Care
Ontario (CCO) that made wait times data accessible and accountable to stakeholders (MacLeod
et al., 2009). CCO was chosen by the Ministry of Health and Long-Term Care to create and
operate the WTIS due to the agency’s past experience with wait time information systems for
radiation treatment (Sullivan, 2009). This system interfaced with the Ontario’s Client
Registry/Enterprise Master Patient Index that was another province-wide system that organized
patient information into an electronic health record (MacLeod et al., 2009). The WTIS
electronically receives near real-time data from surgeon’s offices, diagnostic imaging
departments and hospital information systems except in the case of cardiac surgery, in which
data is received from the Cardiac Care Network (Kramer, 2007). Wait times are measured from
the time the intervention (e.g. surgical procedure or diagnostic imaging) is ordered to the time
the intervention is completed. This system is able to provide wait list management data at the
surgeon, service and hospital level. Physicians can monitor the patients waiting for a specific
surgeon and patients’ wait times in comparison to access targets. Hospitals can track the number
of patients on a wait list by surgeon, medical procedure and facility. The government can assess
the differences in wait times across the province and target their efforts by region. Patients can
search for the shortest wait times of a surgical procedure by health care service and location on
the publicly accessible website, www.ontariowaittimes.com. Since its introduction in October
2005 to February 2009, the website has received about 10 million hits with a daily average of
8000 hits (MacLeod et al., 2009). As of March 2008, the WTIS website also reports the number
of days at which 90 per cent of patients received their treatment and the per cent of patients
completed within the access target by priority level for a particular service (Ontario. Ministry of
Health and Long-Term Care, 2009b).

The WTIS initially focused on five therapies (e.g. cancer surgery, cardiac revascularization
procedures, cataract surgery, hip and knee total joint replacements and magnetic resonance
imaging and computed tomography scans) and later expanded to include all adult and paediatric
surgical procedures. Five paediatric hospitals across Ontario are volunteering to submit wait time
information in 10 subspecialties to the WTIS. Every month, the total number of reported
paediatric cases, as well as the number of days in which 50 per cent and 90 per cent of patients
have received their treatment, are reported by WTIS website (Ontario. Ministry of Health and
Long-Term Care, 2009a). As of March 2009, the WTIS has been implemented in 86 Ontario
hospitals with the involvement of over 3300 physicians and the public reporting of wait times of
over 2.2 million surgical and diagnostic imaging procedures (MacLeod et al., 2009).

Public reporting of wait times has several advantages. Firstly, it democratizes wait times data for
all stakeholders. An information system, such as the WTIS, was an electronic method of
capturing and reporting data that was accessible to patients, physicians, hospitals and the Ontario
government. The public wait times website provided knowledge to patients about their wait times and empowered them to be more active in the decision-making process for their treatment. The accessibility of this information allowed patients to engage in discussions with their providers for the best path of care. For example, a patient could request a referral from their physician to a particular hospital for treatment based on the available wait time data in the region. Physicians are less reliant on manual processes for wait list management if a centralized province-wide system is used for reporting wait times. An information system could help hospitals to monitor their efficiency in comparison to other hospitals in the region and better allocate resources to reduce waits. The public information about wait times help to provide transparency among all stakeholders and hold hospitals and the government accountable to the public.

a. Problems with reporting

Although the electronic accessibility of wait times information is improving for Canadians, the three territories, as well as Newfoundland and Labrador, still do not have websites dedicated to reporting wait times for surgical procedures (Wait Time Alliance, 2009). For the provinces that have accessible wait time websites, the collection and reporting of wait times are unique to each province and not consistent across the country. Wait times are reported by surgical procedure, hospital, region or province as a whole depending on the province. Some provincial websites report median wait times, while others describe wait times as averages or the percentage of cases completed within a certain time period (Health Council of Canada, 2007). Mean wait times are sensitive to outliers and not representative of expected wait times. The reporting of different statistics makes comparisons between provinces difficult. The Canadian Institute for Health
Information (CIHI) examined provincial websites reporting wait times in February 2007 and found that comparisons between websites were difficult due to the lack of standardized data (CIHI, 2007). Therefore, findings from the review were inconclusive in remarking on whether meaningful wait time reductions were achieved or if patients were receiving treatment within access targets.

Wait lists in Canada are not audited by an independent agency. If a patient was placed onto more than one list, had their surgery elsewhere or died, these circumstances would falsely inflate wait lists, whereas patients still waiting for a specialist consultation and needing treatment could contribute to the potential growth of wait lists (Rachlis, 2005). Therefore the validity and reliability of Canadian wait times data are suspect. Fraser (1991) audited surgical wait lists in New Zealand and found that about a quarter of the 2216 wait list patients could not be located or wished to be removed from the list. From those who wished to be removed from the list, a third felt they did not require the surgery anymore and another third had received or planned to have treatment elsewhere. Therefore, continuous auditing of wait lists is an important quality assurance measure and ensures accuracy in the number of patients waiting for treatment.

XII. Consequences of waiting

The consequences of delayed treatment are important when determining access targets to measure the risks of morbidity or mortality. A general conceptual model by Hilkhuysen et al. (2005) outlined the physical, psychological and social consequences of waiting for elective surgery and the relationship among these factors. Physical consequences of waiting include prolonged pain and suffering, deterioration in health and disability that may interfere with daily
activities of living. In conditions such as cardiac disease, the risk of death while waiting for
treatment is a possibility. The experience of living with the illness and its symptoms over time
can also have a psychological impact on the patient. The patient experiences emotional stress and
anxiety as they face the uncertainties of when they will be treated and how waiting will affect
recovery and prognosis. Furthermore, the physical and psychological consequences of a long
wait may impair the social relationships of a patient with family, friends and working colleagues.

Waiting can also affect the work environment by leading to reduced productivity, prolonged sick
leave, and loss of income (Hurst & Siciliani, 2003). Consequences of waiting may differ among
individuals depending on their disease and its severity, length of wait, personality, and presence
of support networks (Hilkhuysen et al., 2005).

a. Consequences of wait times in medicine

Studies have shown that patients waiting for treatment, such as major joint replacement, have a
significantly poorer health-related quality of life compared to the general population (Derrett et
al., 1999; Hirvonen et al., 2006; Williams et al., 1997). In Derrett et al. (1999), patients waiting
for hip or knee joint replacement (HKR) of the 45 to 64 years age group significantly scored
lower in the emotional (SF-36 score HKR: 46.5; SF-36 population score: 80.9), social
functioning (SF-36 score HKR: 49.1; SF-36 population score: 85.7) and mental health (SF-36
score HKR: 62.9; SF-36 population score: 78.9) categories compared to population norms (p <
0.05). The authors reported that the different perceptions of health care and wait list management
between patients and the general population might have explained the variations in the emotional
and social dimensions of HRQoL between these two groups (Derrett et al., 1999).
There is conflicting evidence with regard to the relationship between symptom severity and quality of life during the wait time until treatment. Several hip or knee joint replacement studies found no significant differences in health-related quality of life or symptom severity between patients with short waits and long waits for treatment (Derrett et al., 1999; Kelly et al., 2001; Mahon et al., 2002; Hirvonen et al., 2006). However, recent literature showed significant increase in pain and deterioration of physical function and quality of life during the wait time of patients for elective surgery (Hodge et al., 2007; Davis et al., 2008; McHugh et al., 2008; Ostendorf et al., 2004). A prospective Dutch study by Ostendorf et al. (2004) revealed that wait time was the only predictive factor for the decline of all health-related quality of life measures in those waiting for total hip arthroplasty. However, other groups did not find a relationship between wait duration and quality of life, but used methods that had less power (Kelly et al., 2001) or study designs (i.e. cross-sectional) that could not detect an effect (Derrett et al., 1999).

Negative outcomes such as vision loss, reduced quality of life and increased rate of falls, were experienced by patients waiting more than 6 months for cataract surgery (Hodge et al., 2007). Davis et al. (2008) found that a greater than 6-month wait for revision total joint arthroplasty resulted in significant increases in pain and physical disability. In addition, Mahon et al. (2002) concluded that patients with access targets for total hip arthroplasty of 6 months achieve greater gains in health-related quality of life and distance walked postoperatively than those with longer waits. Preoperative status of a condition may also have effects on recovery and prognosis after treatment. Ostendorf et al. (2004) found that patients with less physical function while waiting
for surgery did not reach the same levels of pain relief and function after surgery compared to those patients with better preoperative function.

Along with the preoperative severity of disease, comorbidities have been examined in patients waiting for treatment and its effects on health-related quality of life. Patients with comorbidities scored significantly lower at baseline in the health-related quality of life measures such as moving, vitality and sexual activity compared to patients without comorbidities (Tuominen et al., 2007). It is evident that comorbidities and their influence on treatment outcomes should be considered in the process of prioritization.

b. Consequences of wait times in dentistry

Dental caries is a common, complex, chronic disease that if untreated, can progress from an innocuous condition into a life-threatening odontogenic infection. Children with dental infections can experience quick deterioration due to poor thermoregulation, less bone density and wider marrow spaces in the jaws that allow for a more rapid spread of infection than in adults (Scutari et al., 1996). Dental disease can also significantly affect and worsen existing comorbidities such as cardiac disease and immunosuppressed states (U.S. Department of Health and Human Services, 2000).

The consequences of early childhood caries (ECC) include pain, inability to eat, and disturbed sleep patterns (Low et al., 1999). Acs et al. (1999) showed that early childhood caries may be associated with a lower rate of weight gain and affect the growth and development of a child. However in Clarke et al. (2006), anthropometric measurements such as height, weight, skinfolds
and arm circumference measurements detected fewer cases of malnourished children with severe ECC compared to blood analysis. Blood values of hemoglobin and ferritin were lower than the standard values in this group and suggestive of severe ECC as a risk marker for iron deficiency anemia that has effects on growth and development (Clarke et al., 2006). Furthermore, the effect of dental caries on social factors such as loss of school days, increased days with restricted activity and decreased ability to learn, have been demonstrated (Gift et al., 1992; Hollister et al., 1993; Reisine, 1985).

Dentistry under general anaesthesia (GA) has been the preferred approach for providing treatment for the very young that are unable to cooperate, those with developmental or medical disabilities or with extensive dental disease. There has been continued interest and growing utilization of dental treatment under GA, especially with children. Alcaino et al. (2000) found an increase of over 700 per cent in the number of children managed under dental GA in New South Wales, Australia from 189 in 1984 to 777 in 1996. A significant rise in the mean wait time for dental surgery was observed from $37 \pm 21$ days in 1984 to wait times of $80 \pm 32$ days in 1996 ($p < 0.05$)(Alcaino et al., 2000). Sweden has also had an increasing number of children and adolescents treated under GA as described in Klingberg et al. (2006). This survey of 34 specialist paediatric dentistry clinics in Sweden found that GA was utilized on 3088 paediatric patients, compared to 2108 patients in 1996 (Klingberg et al., 2006). In Toronto, Canada at SickKids, approximately 1100 children had dental treatment under GA in 2008 with a slight increase of 100 additional patients in 2009 (Dr. Michael Casas, personal communication, Aug 31, 2009). Several studies have shown parental acceptance and satisfaction with dental GA for children...
(Acs et al., 2001; Anderson et al., 2004; Malden et al., 2008; Savanheimo et al., 2005; White et al., 2003).

When the Canadian government placed $10.0 billion into reducing wait times and providing better access to care in September 2004, its objectives focused on five medical areas affecting adults and did not consider the needs of children and wait times. Wait times for paediatric dental treatment under GA are currently being monitored in Ontario, Canada as part of a $2.6 million dollar initiative by the federal government announced on January 11, 2007 (Harper, 2007a). A pilot project was started with five paediatric hospitals in Ontario to target six paediatric surgical areas – cardiac, sight, cancer, neurology, spinal deformity and dental treatment under GA – to guarantee wait times for children in Canada (Harper, 2007a, b). The federal government addressed the high demand for paediatric hospital dental services and acknowledged that oral health was a component of overall health. Paediatric hospitals, such as SickKids, reported wait times of 12 to 14 months after consultation for dental treatment under GA prior to 2005 (Dr. Michael Casas, personal communication, December 10, 2008). The Ontario government has invested an additional $5.5 million to maximize surgical capacity of paediatric hospital services, which has translated into 656 additional dental and oral surgeries across the province (McGuinty, 2007). The extra funding will also aid in the reporting of paediatric wait times information in Ontario (McGuinty, 2007; Spencer, 2007). By September 2008, there were 237 reported paediatric dental cases with 50 per cent and 90 per cent of patients having their treatment within 136 days and 313 days, respectively. (Ministry of Health and Long-Term Care, 2008)
There is currently limited published literature about wait times for paediatric dental treatment under general anaesthesia. North et al. (2006) discussed the effects of time on children waiting for dental extractions under GA due to an interruption in service in Sheffield, UK. They concluded that during the wait period for a dental GA, dental pain was a major issue with 41 per cent needing analgesics. Disturbed sleep (28%), eating difficulties (32.9%), and missed school (9.2%) were also reported (North et al., 2006). In another UK study by Lush and Roebuck (2006), dental pain was common with 65 per cent complaining of pain at least once while waiting for treatment and 25 per cent with daily episodes of pain. These authors also noted an interference with the daily activities of the child and family with 31 per cent of the children missing school and 13 per cent of the parents having to miss work (Lush and Roebuck, 2006).

Casas et al. (2007) showed that high priority dental cases at SickKids were waiting disproportionately long average wait times that were greater than their specified access targets. After the implementation of a prioritization booking system, average wait times decreased for existing and new dental cases with urgent treatment needs and by July 2005, high priority cases were being treated within their access targets. However as a result, the low and moderate priority groups were waiting excessively beyond their access targets. Therefore, the maximum age of eligibility for healthy children with caries was reduced from age 5 to age 2 years at SickKids. These changes reduced the wait list by about 15 per cent in November 2005 and increased the number of children receiving dental treatment within their access targets (Casas et al., 2007).
XIV. Dental Disease Progression in Children

Dental caries is a dynamic process that involves the complex interaction of dental tissues with acidogenic microorganisms and fermentable carbohydrates (Bjorndal, 2008; Featherstone, 2004; Selwitz et al., 2007). An incipient carious lesion begins within a bacterial biofilm on dental hard tissues. A diffusion of calcium, phosphate and carbonate from dental tissues occurs when teeth are exposed to organic acids produced by cariogenic bacteria. This process is called demineralization. If an incipient lesion is provided with a reservoir of calcium, phosphate and fluoride, remineralization of dental tissues can take place (Featherstone, 2004). The balance between demineralization and remineralization influences whether a tooth is in a state of caries progression, quiescence or regression. When pathological factors such as cariogenic bacteria, frequency of fermentable carbohydrates and salivary dysfunction predominate, demineralization is favoured that results in caries progression and the weakening of enamel to produce a cavitation in the tooth structure (Featherstone, 2004; Selwitz et al., 2007).

The literature on the rate of caries progression in children has mainly described the permanent dentition with few studies on the process in primary teeth. The caries progression in permanent teeth was observed to be slow in various studies with enamel caries reaching the dentin in three to six years (Arrow, 2007; Backer Dirks, 1961; Berman and Slack, 1973; Hugoson, 1985; Mejare et al., 1999; Pitts, 1983). Backer Dirks (1961) was one of the first to conduct a longitudinal caries progression study in a group of 100 children assessed annually from age 9 years to 15 years old. Proximal caries was found to progress slowly from enamel to dentin in a permanent tooth with a mean time of 3 to 4 years. Furthermore, Backer Dirks (1966) observed that the caries process started in the pit and fissure areas before proximal surfaces and that 48% of
enamel caries did not progress within 4 years. Mejare et al. (1999) described the slow progression of proximal enamel caries in a cohort of 536 Swedish children followed from 11 to 22 years of age with 75% of lesions still in enamel after six years.

Despite the slow progression of enamel lesions into dentin, the development of incipient lesions in permanent teeth was found to be rapid in several studies (Berman and Slack, 1973; Boyd 1950, 1951, 1952; Gustafsson et al., 2000). Berman and Slack (1973) studied the control group from a dentifrice study described in Slack et al. (1967) that consisted of schoolgirls (ages 11 to 12 years) with annual exams over 3 years. The development of incipient decay was prominent in a minimum of one year after tooth eruption, however the progression of proximal caries to a higher degree was not marked. In a retrospective study by Gustafsson et al. (2000), the median caries progression rate from enamel to dentin was greater than five years in 100 adolescents (ages 14 years to 19 years) with faster progression during the first two years as compared to the following three years.

The extent of lesions in dental tissues may also influence the rate of caries progression in permanent teeth. Zamir et al. (1976) found that within two years, less than 20% of outer enamel caries at baseline progressed to dentin in 51 patients (ages 14 years to 24 years). However, Granath et al. (1980) found that over 50% of inner enamel lesions located on proximal surfaces reached the dentin within 2 years in 126 Swedish children (ages 12 to 13 years). A faster rate of four times was seen in caries progression once the dentin was involved in comparison to enamel lesions, however 50% of the dentino-enamel junction (DEJ) lesions did not progress radiographically after 3.1 years (Mejare et al., 1999).
There is limited information on the rate of caries progression in children. Various studies have evaluated caries progression with the use of preventive interventions such as fluoride treatments that influence the natural rate of dental disease progression in primary teeth (Craig et al., 1981; Murray and Majid, 1978; Shwartz et al., 1984; Vanderas et al., 2003) or without radiographic evaluation to underestimate the presence and progression of enamel caries (Warren et al., 2006). Van Erp and Meyer-Jansen (1970) was one of the few studies to describe caries progression in the primary dentition of children living in an unfluoridated region of Eindhoven and without the influence of preventive interventions. The proximal surfaces of primary molars of 100 children (50 boys and 50 girls) were followed by four-month clinical and radiographic exams from age 4.5 years to 6.5 years. The mean amount of time for an incipient proximal lesion to progress into dentin for primary molars was determined as 7 months radiographically. The rapid caries progression found in primary teeth was attributed to the thinner enamel layer found in primary teeth compared to permanent teeth (Murray and Majid, 1978; Pitts, 1983). Grindefjord et al. (1995) reported that within 12 months, over 70% of incipient lesions in 692 Swedish children (age 2.5 years at baseline) progressed to a cavitated or restored state. This study also concluded that early caries development in children show rapid caries progression as well as a high risk for future carious lesions.

Caries progression has been known to slow down with increased age (Mejare et al., 2004). Mejare et al. (1999, 2004) found that adolescents had a faster caries progression of two to three times from enamel to dentin compared to younger adults. Zamir et al. (1976) also observed that the mean rate of caries progression from the tooth surface to the DEJ was faster in adolescents.
(14-15 year old group: 26.4 months) when compared to young adults (21-24 year old group: 32.3 months) (p < 0.01). This may be related to the formation of secondary dentin as an individual ages that increases the distance between the DEJ and the pulp (Foster, 1998).

XV. Dental Disease Burden

Dental caries is the most common chronic disease afflicting children, being 5 times as common as asthma and 7 times as common as hay fever (U.S. Department of Health and Human Services, 2000). Since the mid 1990s, dental decay in primary teeth of children aged 2 to 11 has shown a significant rise according to the 1999-2004 National Health and Nutrition Examination Survey (National Institute of Dental and Craniofacial Research, 2008). Dental caries is a dynamic disease process that spans a continuum from the initial loss of tooth mineral to cavitation of enamel, dentin or cementum to pulpal infection, necrosis and loss of the tooth (Bjorndal, 2008; Featherstone, 2004). Loss of a primary tooth due to dental disease may have potential consequences in aesthetics, function and space management however, there is commonly a succedaneous tooth that can function in the place of the lost primary tooth.

A spectrum of disease severity and progression exists from enamel and dentin caries to pulp involvement to pulp necrosis and is also affected by the location of decay affecting cavity size, restoration type and prognosis of the restored surfaces. For example, teeth with one carious surface could be considered a different group from similar teeth with caries affecting two to three surfaces or four to five surfaces. Da Rosa Rodolpho et al. (2006) evaluated the survival of composite resin restorations in posterior permanent teeth. Failure was defined as restoration repair (e.g. restoration fracture), restoration replacement (e.g. secondary caries, tooth/restoration
fracture, prosthetics, endodontic reasons) or tooth loss. At 17 years of service, one-surface, two-surface and multi-surface restorations presented with survival probabilities of 49 per cent, 27 per cent and 18 per cent, respectively. The differences between the cavity preparations were statistically significant (p < 0.001) with a greater relative risk of failure for two-surface (2.3 times) and multi-surface restorations (3.3 times) when compared to one-surface restorations. The two most common causes of failure were restoration fracture that required repair (42.9%) and secondary caries that needed restoration replacement (22.4%) (da Rosa Rodolpho et al., 2006).

In Brunthaler et al. (2003), filling extension affected the survival of a restoration with Class II restorations having a statistically significant higher failure rate than Class I restorations (p = 0.03). Moffa (1989) and Wilson et al. (1988) also observed higher failure rates with restorations of the Class II type compared to the Class I type over 5 years. Kreulen et al. (1998) reported that the replacement risk of MOD amalgams was higher (OR = 1.9-2.7) than for MO/DO amalgams over the 15-year follow-up. However, no difference was noted between the survival rates of MO, DO and MOD amalgam restorations in permanent teeth even though there was a difference in cavity size between two surface and three surface restorations (Jokstad and Mjor, 1991).

As caries involves more surfaces of a tooth, the ratio of sound tooth structure to restorative material decreases. The loss of marginal ridge(s), such as in Class II and multisurface restorations, weakens the structural integrity of the tooth and its resistance to fracture. The amount of dentinal support remaining after caries excavation is a risk indicator for tooth fracture (Bader et al., 2004). Mondelli et al. (1980) reported that the Class I preparation affected tooth strength less than the Class II restoration of equal occlusal width. Under excessive loads, Class I restorations are less likely to fracture due to the dissipation of forces onto the remaining hard tissues. However in Class II restorations, the forces tend to remain in the cavity and direct...
stresses horizontally towards the cavity walls resulting in tooth fracture (Mondelli et al., 1980). In a case-control study of cusp fractures in restored posterior teeth, the relative volume proportion (RVP), which was the area of a restoration in three dimensions, was a strong risk indicator for tooth fracture (Bader et al., 2004). The RVP also represented an inverse measure of the remaining tooth material. The study found that a 10 per cent increase in the volume proportion of a restoration was related to a six-fold increase in the odds of fracture (Bader et al., 2004). Therefore, the extent of the cavity preparation influences the survival of the restoration and the tooth from masticatory forces.

Recurrent caries that lead to the re-restoration of a one-surface restoration (e.g. occlusal, buccal or lingual), in most instances, do not extend beyond the initially treated tooth surface. However in a two or three surface restoration (e.g. mesio-occlusal or mesio-occlusal-distal restoration) with secondary caries, the new restoration would likely affect more of the tooth structure and extending onto new surfaces (e.g. stainless steel crown). The concept of tooth re-restoration resulting in larger restorations and less original tooth structure is well accepted among dentists. Unfortunately, this concept is based on clinical practice and evidence-based research is limited with regard to tooth-based analyses and quantification of re-restored surfaces. Brantley et al. (1995) found that 70 per cent of all recommendations to replace existing restorations in posterior teeth resulted in an increased number of restored surfaces in treatment planning. Elderton & Osman (1991) and Anusavice (1989) also agreed that re-restoration could lead to larger restorations with possible damage to adjacent teeth and decrease in tooth fracture resistance as the isthmus width increases (Anusavice, 1989).
As more of the tooth surfaces are affected by caries, the amount of remaining sound tooth structure to protect the pulp decreases due to the extent of diseased tissues and the type of restoration. Felton et al. (1989) and Stanley (1993) discussed the effects of crown preparation on tooth vitality and the increasing incidence of pulp necrosis associated with full-coverage restorations. Teeth that require pulp therapy could be considered as a greater disease burden compared to teeth with dentinal caries. A matched cohort study by Caplan et al. (2005) evaluated the effect of pulp involvement and subsequent endodontic treatment on tooth survival by using a treatment database from a large dental health maintenance organization. Over an 8-year follow-up, root canal filled (RCF) teeth had significantly worse survival than the non-root canal filled contralateral teeth (p < 0.001). The unadjusted hazard ratio and 95 per cent confidence interval for RCF versus non-RCF teeth was 3.0 (1.4-6.1), signifying that RCF teeth were extracted at a rate three times that of non-RCF teeth (Caplan et al., 2005). Endodontic therapy prolonged the survival of a pulpally involved tooth. However, the impact of pulp pathosis and root canal treatment ultimately decreased the lifespan of the tooth (Caplan et al., 2005).

When a tooth is deemed non-restorable due to extensive caries and infection, extraction is the only treatment option. A tooth planned for extraction due to caries has a more severe disease burden than the same tooth with dentin caries or pulp involvement. Functional, aesthetic and orthodontic consequences may result due to premature loss of a tooth. An extracted primary tooth will likely have an underlying permanent successor however an extracted permanent tooth can only be replaced by a prosthetic tooth, treated with orthodontic intervention or left as a space in the dental arch.
Summary of the Literature Review

Single-payer health care systems intend to provide universal access to medical services on the basis of need rather than the ability to pay. Fiscal restraints threaten universal access to health care by limiting hospital resources that in turn affect patient wait times for treatment. Wait times exist due to a greater demand by the public for services compared to the available hospital capacity. Canadians experienced longer wait times for treatment due to reduced hospital capacity in response to the economic decline and increasing health care costs since the 1990s (Irvine et al., 2005).

Supply-side strategies such as increasing funding to expand the capacity of a system are commonly employed to reduce wait times in health care. Demand-side strategies such as implementation of priority systems have been utilized to improve surgical wait times in areas such as hip and knee joint replacement surgery, cataract surgery, diagnostic imaging and paediatric dentistry (Casas et al., 2007; MacCormick et al., 2003a; Noseworthy et al., 2003). New Zealand, Spain and Western Canada developed priority criteria on the basis of clinical factors (e.g. severity of the patient’s condition and potential to benefit) and non-clinical factors (e.g. ability to work, live independently, or care for dependents) for patient prioritization (Allepuz et al., 2008; Derrett et al., 2003; Escobar et al., 2007; Western Canada Waiting List Project, 2001). New Zealand was the only country that implemented priority scoring systems in health care however, problems with CPAC ensued due to its lack of validity and reliability testing beforehand.
Limited evidence is currently available on wait times and prioritization in paediatric dentistry. Dentistry under GA is an essential service for children who are young, unable to cooperate, with complex medical histories or with extensive decay. Children who require dental treatment under GA in a hospital-based setting also experience long wait times due to reductions in health care funding and the restructuring of hospital resources.

The following manuscript describes a review of patient records selected to determine whether prescribed access targets for elective dental treatment under general anaesthesia at SickKids (The Hospital For Sick Children) are clinically relevant by assessing incremental changes in dental disease burden during the wait to receive treatment. The clinical relevance of the current wait time paradigm will be evaluated based on whether disease burden significantly increases as a function of the time elapsed from consultation to treatment.
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The clinical relevance of access targets for elective dental treatment under general anaesthesia in paediatrics

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Running Title: The clinical relevance of access targets

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Chung SS, Casas MJ, Kenny DJ, Barrett EJ. The clinical relevance of access targets for elective dental treatment under general anaesthesia in paediatrics. JCDA 200X;
Objective: To evaluate the clinical relevance of access targets for elective dental treatment under general anaesthesia (GA) at SickKids (The Hospital For Sick Children) by assessing incremental changes in dental disease burden over wait times for dental GA.

Methods: Children scheduled for elective dental GA were prioritized according to their dental diagnosis and medical risk status. Each priority level was defined by a specific diagnostic code and access target (maximum acceptable wait time). Dental records of children with dental GAs completed between June 2005 and December 2008 were assessed retrospectively. A novel assessment scale measured the cumulative dental disease burden during dental GA wait times.

Results: A total of 378 children (age range: 10 months to 17 years old) met the inclusion criteria. Statistically significant correlations were identified between disease burden and wait times for priority group IV (access target = 90 days) ($p = 0.004$), the entire sample ($p < 0.003$), children with advanced dental caries and low medical risk ($p = 0.005$), comorbid ($p = 0.036$), healthy ($p = 0.0002$), female ($p = 0.014$) and male ($p = 0.008$) groups. The mean cumulative disease burden over time was not different between matched healthy and comorbid groups ($p = 0.38$).

Conclusions: A trend suggestive of increasing dental disease burden for children with longer wait times for elective dental GA was found but not clinically significant. Refinements in the novel assessment scale and a better understanding of the natural history of dental disease will likely be useful in developing clinically relevant access targets.

Dental treatment under general anaesthesia (GA) is often indicated for children with complex medical conditions, who are uncooperative for dental care or with extensive dental needs. Hospitals that provide dental care under GA have reported wait times of 40 to 60 weeks$^{2,3}$ from
consultation to treatment. These waits are longer than the wait times for either ophthalmic (10.6 weeks) or otolaryngologic (11.7 weeks) services under GA.\textsuperscript{4}

Wait time literature in paediatric dentistry has focused on the consequences of delayed dental treatment\textsuperscript{5,6} and only one paper has described the use of a prioritized scheduling system for elective dental treatment of children under GA\textsuperscript{7}.

\textit{SickKids Prioritization System}

The National Paediatric Surgical Wait Times Strategy developed a seven-level prioritization system in 2005 to prioritize children for elective surgery in Canada\textsuperscript{8} (Table 1). The SickKids Dental Department followed with a similar system that utilized 9-letter diagnostic codes (Table 2) to describe the child's medical and dental status (e.g. DOSACDACA = dental abscess, low medical risk). Each child was assigned a diagnostic code at the time of decision to treat (DTT), when the individual consented to dental treatment under GA. Diagnostic codes were linked to priority levels and associated access targets (maximum acceptable wait times). An access target was based upon the anticipated effect of the dental diagnosis on any existing medical comorbidity. Paediatric surgical access targets in Canada were consensus-based and implemented at paediatric hospitals to aid in the prioritization of children for surgery. The objective of this study was to determine the clinical relevance of prescribed access targets for elective dental treatment under GA at SickKids by assessing incremental changes in dental disease burden over the wait time for dental treatment. The clinical relevance of the current wait time model will be evaluated based on whether disease burden significantly increases during the time elapsed from consultation to treatment.
Methods

Patient Record Selection

A password-protected database (FileMaker Pro, Version 8.5.1; FileMaker, Inc., Santa Clara, Calif.) was designed to contain wait time data for patients (ages 0 – 17 years) scheduled for elective dental treatment from May 2005 onwards. One investigator (SSC) conducted a retrospective review of patient records from the database and hand searched dental charts to assess eligibility for inclusion.

The inclusion criteria were:

a) Planned elective dental treatment under GA
b) DTT date between May 2005 and September 2008
c) Preoperative dental assessment completed and verified for accuracy by a staff paediatric dentist
d) Report of dental treatment completed on the day of the dental GA

The Research Ethics Board at SickKids granted approval (REB application no. 1000012706) for this investigation.

Data Collection

A spreadsheet was used to organize data of eligible patient records. An identification number was used to anonymize patient records in place of patient identifiers. The wait time for each
child was the number of days elapsed from the DTT date until the GA date. The number of days waiting beyond the access target was the difference between the wait time and the prescribed access target for each child’s assigned diagnostic code. The change in disease burden during the wait time for each child was scored using a novel assessment scale.

**Novel Assessment Scale**

Two expert panel meetings were conducted in November and December 2008 with five SickKids staff paediatric dentists to form a consensus-based assessment scale. An ordinal scale that was comprised of increasing levels of disease burden for the primary and permanent dentition was developed (Figure 1).

The expert panel ranked disease burden on the scale based on treatment required and treatment outcomes. The endpoints of the scale were sound tooth structure and permanent tooth extractions that produced functional and/or aesthetic and/or orthodontic consequences as the most severe level of disease burden. This scale described the change in disease burden for individual teeth as a positive, negative or zero integer. A positive score indicated an increased disease burden over time (e.g. two-surface carious lesion on a primary anterior tooth at DTT time that progressed to pulp therapy at the time of treatment would produce a score of + 2). A negative score represented a decreased disease burden at treatment time than assessed at the DTT date (e.g. pulp therapy planned on a primary posterior tooth at DTT time but treated as a two-surface restoration at dental GA would produce a score of - 3). A zero score represented comparable levels of disease burden at the DTT date and the treatment date and was assessed as no change in the overall disease burden of a child. Disease burden scores ranged from -12 to + 12 for each tooth and
represented the number of disease burden levels a tooth would advance over time but not the magnitude between these levels. For example, if a primary maxillary incisor was planned for a restoration at the DTT date but required additional treatment, i.e. the planned restoration plus pulp therapy on the date of treatment, disease burden was deemed to have increased during the wait time but the magnitude of the increase was unknown. The total score for each child was the summation of scores from all existing teeth. Primary mandibular incisors, orthodontic extractions and teeth that exfoliated during the wait for treatment were excluded. Primary mandibular incisors were excluded from the scale as the treatment philosophy for these teeth varied between enameloplasty of incipient decay or extraction at this hospital. The decision to exclude primary mandibular incisors resulted from the potential for divergent scoring due to the limited treatment options or disease burden levels for these teeth.

**Statistical Methods**

The sample was divided into subgroups by priority level, diagnostic code, medical status (with or without comorbid conditions) and gender for analysis. Observations were graphically represented on a scatter plot and best-fit trend lines were calculated by linear regression. The correlation between the number of days waiting beyond the access target (independent variable) and total score or change in disease burden (dependent variable) was evaluated using Pearson’s correlation coefficient \( r \). To assess for differences between the groups with or without comorbid conditions, matched pairs were selected from each group with each pair matched for age in months, gender and priority code. A paired-samples t-test was performed. SAS software (version 9.1; SAS Institute Inc., Cary, NC) was used for statistical analysis. A p-value of 0.05 or
less was considered statistically significant. A descriptive summary was completed for study
patients seen on emergency at SickKids during the observed wait time.

**Results**

The dental records of 378 children (179 female, 199 male) seen for consultation between May
2005 to September 2008 were included. The mean patient age at the time of DTT was 4.95 ±
3.68 (SD) years. The sample had 288 children (76%) with comorbid conditions. The two largest
subsets, priority III (access target: 42 days) and priority IV (access target: 90 days) comprised
26.4 per cent and 70.4 per cent of bookings respectively (Table 3). The mean number of days
waiting beyond the access targets was 121.9 ± 125.3 (SD) days. Thirty-seven (9.8%) children
were seen on emergency for dental pain (28/37), swelling (6/37), trauma (2/37) and exfoliating
teeth (1/37) during their wait for dental treatment under GA.

Statistical analysis was completed on the larger subsets of the sample (e.g. priority III and IV;
diagnostic codes DOSDCADCA, DOSDCADBA) since they were deemed to be representative
of children treated at SickKids. Priority III showed a small positive correlation that was not
statistically significant ($r = 0.112$, $p = 0.267$) (Figure 2). The correlations of Priority IV ($r =
0.176$, $p = 0.004$) and the entire sample ($r = 0.184$, $p < 0.003$) were statistically significant
(Figure 2). The data set was also organized by diagnostic code, medical status and gender. The
two largest groups consisted of cases diagnosed with advanced visible carious lesions and low
medical risk, DOSDCADCA group ($n = 181$), and those with moderate medical risk,
DOSDCADBA group ($n = 63$). Both groups had correlations that were small and positive, but
only the DOSDCADCA group was statistically significant ($r = 0.210$, $p = 0.005$) (Figure 3).
Groups with comorbid conditions ($r = 0.124, p = 0.036$) and without comorbid conditions ($r = 0.387, p = 0.0002$) presented with correlations that were small and statistically significant (Figure 4). Correlational analysis of gender was similar in magnitude and statistically significant (female: $r = 0.183, p = 0.014$; male: $r = 0.188, p = 0.008$) (Figure 5). However the difference of the mean total scores of gender groups was not statistically significant ($t = -1.11, p = 0.27, df = 376$).

Regression analyses of the subgroups produced slopes that approximated a zero value ($b \leq 0.01$). This indicated that large increases in the number of days waiting beyond the access target were associated with small increments in disease burden of this sample (Table 4).

Forty-three matched pairs by age, gender and priority code were obtained from the groups with and without comorbid conditions. The mean total change in disease burden was not statistically significant ($t = 0.89, p = 0.38, df = 42$) between groups with (mean = 4.72, SD = 8.35, n = 43) and without comorbid conditions (mean = 6.30, SD = 8.17, n = 43).

**Discussion**

This investigation is the first to study elective GA access targets in paediatric dentistry. The majority of patients (79.4%) did not receive a dental GA within their access targets. Long wait times resulted in emergency visits from 37 children (9.8%) with dental pain as their most common complaint (28/37), which is similar to results found in Lush & Roebuck and North et al.
The access targets employed in this study were consensus-based and used by all surgical services with operating room (OR) time. Since the access targets were not specific to dental disease, it was important to determine whether their use would result in children receiving dental treatment before their condition appreciably worsened. Given this model, the prescribed access targets would be considered clinically relevant if the dental disease burden of children did not increase when wait times approximated the access targets. The major assumption of this study was that severity of dental disease would increase between the DTT and treatment dates. However this was not supported by the data. Regression analyses demonstrated small increases in the rate of dental disease over time for this sample but these results were not clinically significant, as slopes approximated zero ($b \leq 0.01$). The most likely explanation for this finding is that by the DTT date at SickKids, patients presented with dental disease burden that had approximated maximal severity.

Although the SickKids prioritization system showed good face validity, the clinical relevance of the access targets could not be demonstrated due to the increase in dental disease burden, albeit minimal, between consultation and treatment dates. It is possible that the correlation between wait times and the change in dental disease burden may have been hindered by factors such as the dental priority criteria, the assessment scale, the accuracy of treatment planning on the DTT date and/or the dental disease state.

In this study, patients were prioritized based on only two criteria: dental diagnosis and medical risk. Since these two criteria were already assessed in children that required a dental GA, this system was clinically efficient. However, the simplicity of the prioritization system may have
excluded important clinical and non-clinical factors, such as dental age and oral health-related quality of life (OHQoL). Dental age may be inversely related to the patient’s urgency for treatment of dentin caries as the pulp to crown ratio is larger in younger children and the risk of abscess prior to treatment is potentially greater than for older children. Similarly, a child’s quality of life may be adversely affected by pulpal pain from untreated caries that impair daily activities of living. A decreased OHQoL of a child may indicate a higher priority for dental treatment.

Existing measures of dental disease burden, such as the DMF index by Klein and Palmer, were deemed inadequate to describe gradations in severity of progressive dental disease. Lack of alternatives led to the development of a novel assessment scale based on expert consensus. The assessment scale was used to measure change in disease burden for each tooth during the wait time, but did not quantify the magnitude of change between disease burden levels. Future studies could utilize VAS or Likert-type scales rated by caregivers, patients or paediatric dentists to discern differences between successive levels of dental disease, similar to prioritization studies in medicine.

Clinical examination and radiographs may have been limited by patient cooperation on the DTT date due to age or comorbid conditions. These factors may have affected diagnosis of the quantity and severity of caries at the DTT time and may in turn have affected accuracy of scoring. Despite this limitation, it was expected that the disease burden scores would not be adversely affected due to the large sample size and clinical experience of staff paediatric dentists. Scoring may have also been affected by previous treatment planning practices. In the past, staff
paediatric dentists at SickKids planned for treatment in anticipation of caries progression during longer waits for dental GA since it allowed families to be aware of potential costs and aided in OR time allocation. For this study, staff paediatric dentists were instructed to plan treatment on the DTT date as if the child were to be treated that day. The previous system of treatment planning with allowance for disease progression may have biased data.

It is possible that there was minimal change in disease burden during the wait for treatment, as SickKids is a tertiary care centre and often the final point of care for children with dental needs. Consequently, in many instances, the dental disease was so advanced at DTT time that only minimal progression was likely. Most of the disease progression may have occurred during the wait for their primary community-based dental provider, often followed by referral to a paediatric dentist and finally referral to the hospital. Therefore, documentation of disease progression would be more likely if prioritization occurred much earlier in the caries process. Results from this study may only be comparable to other paediatric tertiary care hospitals.

Conclusions

This investigation was the first to evaluate the clinical relevance of access targets in paediatric dentistry and to devise a novel assessment scale of dental disease that accounted for severity and progression. The increase of dental disease burden beyond the access targets was minimal as patients presented with an advanced state of dental disease on DTT day. Since most of the disease progression occurred prior to consultation, the current model for GA access targets in paediatric dentistry may be more relevant in community-based settings than at tertiary care centres. Despite the limitations of this study, a trend of increasing dental disease burden for
children was associated with prolonged wait times for elective dental treatment under GA. Further assessment of SickKids access targets may benefit from refinements of the disease burden scale and a better understanding of the natural history of dental disease.

Table 1. Priority levels and designated access targets (National Paediatric Surgical Wait Times Strategy)⁷

<table>
<thead>
<tr>
<th>Priority</th>
<th>Access Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Within 24 hours</td>
</tr>
<tr>
<td>IIa</td>
<td>Within 1 week</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
</tr>
<tr>
<td>IIb</td>
<td>Within 3 weeks</td>
</tr>
<tr>
<td>III</td>
<td>Within 6 weeks</td>
</tr>
<tr>
<td>IV</td>
<td>Within 3 months</td>
</tr>
<tr>
<td>V</td>
<td>Within 6 months</td>
</tr>
<tr>
<td>VI</td>
<td>Within 12 months</td>
</tr>
</tbody>
</table>

Table 2. Illustrative diagnostic codes and associated priority levels

<table>
<thead>
<tr>
<th>Diagnosis Code</th>
<th>Description</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOSACSFCA</td>
<td>Unilateral Facial Cellulitis</td>
<td>IIa</td>
</tr>
<tr>
<td>DOSDCADAA</td>
<td>Advanced Dental Caries: visible carious lesions and/or pain – high risk medical status</td>
<td>IIa</td>
</tr>
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</table>
### Table 3. Summary of the mean total scores and mean number of days waiting beyond the access target of priority levels

<table>
<thead>
<tr>
<th>Priority</th>
<th>Access target (days)</th>
<th>Sample size</th>
<th>Mean total score</th>
<th>Mean number of days waiting beyond the access target</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Group</td>
<td>n</td>
<td>Slope (b)</td>
<td>p-value</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td>-----------</td>
<td>-------------</td>
<td></td>
</tr>
<tr>
<td>Priority III</td>
<td>100</td>
<td>0.01</td>
<td>0.267 (n.s.)</td>
<td></td>
</tr>
<tr>
<td>Priority IV</td>
<td>266</td>
<td>0.01</td>
<td>0.004*</td>
<td></td>
</tr>
<tr>
<td>All priorities</td>
<td>378</td>
<td>0.01</td>
<td>0.0003*</td>
<td></td>
</tr>
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</table>

Table 4. Regression analyses by priority level, diagnostic code, medical status and gender groups
<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
<th>p-value</th>
<th>Significant?</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOSDCADCA</td>
<td>181</td>
<td>0.01</td>
<td>0.005*</td>
</tr>
<tr>
<td>DOSDCADBA</td>
<td>63</td>
<td>0.003</td>
<td>0.816 (n.s.)</td>
</tr>
<tr>
<td>Healthy</td>
<td>91</td>
<td>0.008</td>
<td>0.0002*</td>
</tr>
<tr>
<td>Comorbidity</td>
<td>287</td>
<td>0.009</td>
<td>0.036*</td>
</tr>
<tr>
<td>Female</td>
<td>179</td>
<td>0.01</td>
<td>0.014*</td>
</tr>
<tr>
<td>Male</td>
<td>199</td>
<td>0.01</td>
<td>0.008*</td>
</tr>
</tbody>
</table>

n.s. – not significant  
* Statistically significant
Figure 1. Scale to score change in dental disease burden
Figure 2. Correlational analysis of priority III, IV and the entire group
**Figure 3.** Correlational analysis of DOSDCADCA and DOSDCADBA groups
Figure 4. Correlational analysis of the healthy and comorbidity groups
**Figure 5.** Correlational analysis of the gender groups
References


Conclusions

This investigation is novel in its evaluation of elective GA access targets for patient prioritization in paediatric dentistry. Previous studies examined the use of priority criteria and point-count measures to rank patients appropriately on wait lists for elective surgery. The assignment of access targets to priority scores for elective treatment is valuable if the potential to benefit from treatment declines the longer the patient has to wait for surgery. This study utilized clinical outcomes with an assessment scale that was developed by consensus of paediatric dentists to assess the relevance of elective GA access targets.

Longer wait times were associated with an increasing trend of dental disease burden for children scheduled for elective GA. However, the rate of disease progression was minimal alongside large increments in the number of days waiting beyond the access target. Minimal disease progression might be attributable to many patients presenting with an advanced state of dental disease burden by the time of GA consultation at SickKids. Most of the dental disease progression was presumed to have occurred during the wait for primary care and through the interval that elapsed until consultation and treatment at SickKids.

This study is the starting point for further investigations of dental disease progression in children and clinically relevant access targets for elective dental treatment. Future studies may focus on dental disease progression from the child’s first contact with the dental health care system until the completion of care in the tertiary health care setting. Refinements in the assessment scale are needed to account for the magnitude between ordinal levels of dental disease. The VAS or Likert type scales along with oral health quality of life measures could be rated by caregivers, children
or paediatric dentists for the assignment of weights for dental diagnoses and increase the
precision of the scale. The financial and psychosocial effects of dental disease could also be
considered for the weighting of the assessment scale. This study utilized every tooth of a patient
as a single unit of measure for dental disease progression. The change in disease burden over
time was determined per tooth since the tooth unit was convenient for data collection and already
used in the planning and billing of dental treatment. However the disease state of one tooth can
raise a child’s priority to a higher level. Therefore, assessment of caries patterns within
individual children may be an alternative method to measure disease burden and may allow
prioritization of children more accurately for elective GA rather than tooth-unit measures. The
priority criteria in this study only included dental diagnosis and comorbidities that affected
medical risk since they were deemed to be the main factors in prioritization for elective GA.
Other factors (patient, parent, quality of life, economic) that may result in alternate priorities
should be identified in further investigations and considered in terms of the content validity of
the priority criteria. Once improvements in the measures of dental disease progression are
established, the clinical relevance of revised elective GA access targets can be reassessed.