

Regional Variation in Dental Procedures among People with an Intellectual Disability, Ontario, 1995–2001

• Robert S. Balogh, MSc •
 • H el ene Ouellette-Kuntz, MSc •
 • Duncan J.W. Hunter, PhD •

A b s t r a c t

Background: The literature indicates that people with an intellectual disability have a prevalence of dental caries that is either lower than or similar to that of the general population. However, many of their caries go untreated, and extractions are more often used as a means of treatment than in the general population. A substantial percentage (40%) of day admissions to hospital of people with intellectual disabilities in Ontario is related to dental diseases. In this paper, we examine whether rates of in-hospital dental procedures are evenly distributed across Ontario and discuss possible explanations for the findings.

Materials and Method: A retrospective analysis was made of routinely collected hospital admission data for people with an intellectual disability. Age- and gender-adjusted rates for dental procedures were calculated using the direct method of adjustment and 1996 census population estimates of Ontario. Three different summary measures for the assessment of regional variation were used.

Results: Two areas had dental procedure rates among those with an intellectual disability that were significantly lower than the overall Ontario rate: Hamilton-Wentworth and Quinte-Kingston and Rideau. The 3 district health council areas with the highest rates for dental procedures were Niagara, Essex-Kent and Lambton, and Durham-Haliburton-Kawartha and Pine Ridge; all 3 rates were higher than the overall Ontario rate.

Conclusions: The use of day surgery and in-hospital visits to treat dental diseases in people with an intellectual disability varies considerably by region in Ontario. Observed differences may indicate inequities.

MeSH Key Words: Canada; dental care for disabled; dental service, hospital; health services accessibility

  J Can Dent Assoc 2004; 70(10):681
 This article has been peer reviewed.

People with an intellectual disability (a condition of mental impairment present or occurring during a person's formative years that is associated with limitations in adaptive behaviour¹) represent approximately 1% of the population in Ontario.² Until 30 years ago, many lived in institutions where most of their health and dental care needs were looked after.^{3,4} In the 1970s and 80s, changes in Ontario government policies led to a shift from institutional residences to community-based homes.^{5,6} The new community residents had to rely on community dental practitioners to provide preventive and restorative services. It was assumed that community-based health and dental

services would be able to handle the influx of people with an intellectual disability. Specialized dental programs for those with disabilities exist only in some large metropolitan centres.⁷

There is increasing concern that community-based services may not be meeting the oral health needs of those with an intellectual disability. A Swedish study published in 1985 found that, among severely mentally impaired individuals, children not living in institutions were most likely to have dental caries.⁸ Another study from Sweden published in 1997 showed that people with mild mental impairment living in independent residences had a higher

prevalence of caries than people with the same level of impairment living in institutions.⁹ More recently, a Swedish longitudinal study of 55 adults with intellectual disability seen by a dentist annually for 4.7 years before and after leaving an institution to live in the community found that, although the number of visits to a dental clinic decreased, there had been no increase in dental caries.¹⁰ However, recent British studies¹¹ showed that people with an intellectual disability living in the community have significantly more untreated decay and are less likely to have a dentist or use community dental services. Furthermore, those who have moved from an institution do not receive dental examinations as frequently as they did when living in the institution.¹² Canadian studies with similar designs could not be found.

The literature indicates that those with an intellectual disability have a prevalence of dental caries either lower than or similar to the general population^{8,13,14}; 2 Canadian studies corroborate these findings.^{3,15} However, there is also evidence that, among those with an intellectual disability, many caries go untreated and extractions are more often used as a means of treatment than in the general population.^{9,13}

This study stems from research looking at hospital utilization by people with an intellectual disability in Ontario from 1995 to 2001.¹⁶ Results showed that a substantial percentage (40%) of day admissions to hospital were related to dental diseases. Dental procedures were among the most frequent treatments provided for people with an intellectual disability admitted to hospital. In this paper, we examine whether rates of in-hospital dental procedures are evenly distributed across the province of Ontario and discuss possible explanations for the findings.

Materials and Method

All records of in-hospital stays and day-surgery visits in Ontario, between April 1995 and March 2001, for residents of Ontario with an intellectual disability, 20–64 years of age, were included in the study of dental procedures. Data were obtained from the Discharge Abstract Database, which contains clinical information on all patients treated in hospital; the database was made available by the Canadian Institute for Health Information.

Records for in-hospital and day-surgery visits of people with an intellectual disability were extracted using the following *International Statistical Classification of Diseases* (9th revision) diagnostic codes¹⁷: intellectual development delay (315.9), mental retardation (319), mild mental retardation (317), moderate mental retardation (318.0), severe mental retardation (318.1), and profound mental retardation (318.2). Records for people with Down syndrome (758.0), autism (299.0), fetal alcohol syndrome (760.71), and Rett's syndrome (330.8) were also included in the study because these are common causes of intellectual disability.

Records were included whether the diagnosis of intellectual disability was coded as the diagnosis most responsible for admission to hospital or as a comorbidity. A scrambled unique identifier was used to identify all admissions for a given person.

All analyses were conducted using procedures included in Statistical Analysis Software (SAS Institute Inc., Cary, N.C.). Rates for dental procedures were calculated. The codes used for dental procedures were: surgical extraction of tooth (35.09, 35.19), restoration of tooth by filling or other (35.2, 35.49) and dental scaling, polishing and debridement (10.64). Rates per 100,000 population were calculated by dividing the average number of procedures per year by the number of people 20–64 years of age with an intellectual disability in Ontario in 2001 (the latter information was obtained from the Ministry of Community, Family, and Children's Services). Procedure rate calculations included day surgery, in-hospital stays and acute and non-acute admissions. Exclusion criteria included cancelled procedures and procedures occurring during prior admissions.

To account for the contribution of possible changes in the age and gender structure of the hospital or day-surgery population in each district health council area, age- and gender-adjusted rates for dental procedures were calculated using the direct method of adjustment and 1996 census population estimates for Ontario.¹⁸

A table and plot were generated to compare areas according to age- and gender-standardized dental procedure rates. A chi-squared test was used to compare the adjusted rates for each area with the overall rate for the province. A significance level of 0.003 (0.05/16) was used to adjust for multiple comparisons. Ninety-five percent confidence intervals (CIs) were calculated for the adjusted rates using the Spiegelman method.¹⁹ Three standard summary measures for regional variation were calculated: the extremal quotient, the coefficient of variation and the systematic component of variance (SCV).²⁰ The extremal quotient is the ratio of the highest to the lowest rate. The coefficient of variation is the standard deviation of rates over the mean rate. The SCV was developed to provide a measure of variation that is stable across a range of rates and population sizes.^{20,21}

Ethics approval for this study was obtained from the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board and the Canadian Institute for Health Information.

Results

Dental procedures made up 40% of day-surgery visits during the study period, and tooth extraction was the most common procedure (15%). Dental procedures were rare during in-hospital stays (0.6%) (Table 1).

Table 1 Frequency of dental procedures in Ontario hospitals, April 1995 to March 2001

Dental procedure	Day-surgery visits	In-hospital stays	Total
	n (%)	n (%)	n (%)
Surgical extraction of tooth	1,885 (15.2)	104 (0.4)	1,989 (4.9)
Tooth filling	1,081 (8.7)	16 (0.1)	1,097 (2.7)
Dental scaling, polishing, debridement	932 (7.5)	8 (0.0)	940 (2.3)
Extraction of other tooth	627 (5.1)	38 (0.1)	665 (1.6)
Other dental restoration	453 (3.7)	9 (0.0)	462 (1.1)
Total dental procedures	4,978 (40.3)	175 (0.6)	5,153 (12.6)
Total admissions to hospital	12,361 (100)	28,473 (100)	40,834 (100)

Table 2 Crude and age- and gender-adjusted dental procedure rates per 100,000 for those with an intellectual disability, 20–64 years of age, by district health council area of patient residence in Ontario, April 1995 to March 2001

District health council	No. procedures ^a (6 years)	No. residents	Crude rate per 100,000	Age- and gender-adjusted rate per 100,000	95% confidence interval	Significance (chi-squared test)
Hamilton-Wentworth	114	1,669	1,138.4	1,118.1	599.5–1,636.8	$p < 0.001$
Quinte-Kingston and Rideau	216	3,003	1,198.8	1,178.2	780.0–1,576.4	$p < 0.001$
Waterloo-Wellington-Dufferin	183	1,665	1,831.8	1,826.6	1,164.2–2,489.0	
Grand River	107	991	1,799.5	1,850.9	983.2–2,718.5	
Thames Valley	234	2,063	1,890.5	1,917.5	1,307.1–2,527.9	
Halton-Peel	202	1,666	2,020.8	1,938.7	1,215.9–2,661.4	
Algoma-Cochrane-Manitoulin and Sudbury	276	2,379	1,933.6	1,982.7	1,394.7–2,570.6	
Northwestern Ontario	145	1,074	2,250.2	2,130.4	1,264.2–2,996.7	
Grey-Bruce-Huron and Perth	182	1,316	2,305.0	2,296.8	1,459.1–3,134.5	
Champlain	499	3,344	2,487.0	2,540.5	1,987.5–3,093.6	
Toronto	712	4,511	2,630.6	2,608.9	2,131.5–3,086.3	
Muskoka-Nipissing and Parry Sound	206	1,351	2,541.3	2,675.6	1,750.8–3,600.3	
Simcoe-York	404	2,453	2,744.9	2,698.7	2,026.3–3,371.0	
Niagara	349	1,513	3,844.5	3,860.6	2,829.6–4,891.5	$p < 0.001$
Essex-Kent and Lambton	647	2,285	4,719.2	4,653.6	3,766.6–5,540.7	$p < 0.001$
Durham-Haliburton-Kawartha and Pine Ridge	677	2,355	4,791.2	4,907.0	4,004.4–5,809.6	$p < 0.001$
Total for Ontario	5,153	33,638	2,553.2	2,534.3	2,362.7–2,705.9	
Extremal quotient				4.4		
Coefficient of variation				43.6		
Systematic component of variation				153.2		

^aIncludes in-hospital stays, day surgery and acute and non-acute care admissions to hospital.

Table 2 presents the dental procedure rates for those with an intellectual disability per 100,000 population by district health council area of Ontario. In 2 areas, dental procedure rates were significantly lower ($p < 0.001$) than the overall Ontario rate (2,534.3): Hamilton-Wentworth (1,118.1) and Quinte-Kingston and Rideau (1,178.2). The 3 areas with the highest dental procedure rates were Niagara (3,860.6), Essex-Kent and Lambton (4,653.6) and Durham-Haliburton-Kawartha and Pine Ridge (4,907.0); all 3 were higher than the overall Ontario rate ($p < 0.001$). The coefficient of variation (43.6) and the SCV (153.2) are high, indicating variation among the areas. Figure 1 presents the age- and gender-adjusted dental procedure rates in the 16 areas compared with the overall Ontario rate.

Discussion

A substantial percentage (40%) of admissions to hospital for people with an intellectual disability are for dental diseases. This finding can, in part, be explained by the frequent need to sedate or anesthetize people with an intellectual disability to carry out dental procedures safely. Hotel Dieu Hospital in Kingston, Ontario, provided statistics for all day-surgery procedures that took place at the facility between April 2001 and March 2002: out of 6,239 admissions, 94 were for dental procedures (1.5%). It is unknown whether all day-surgery admissions for dental work for people with an intellectual disability are appropriate.

There is some evidence that general anesthesia is overused in people with an intellectual disability who are

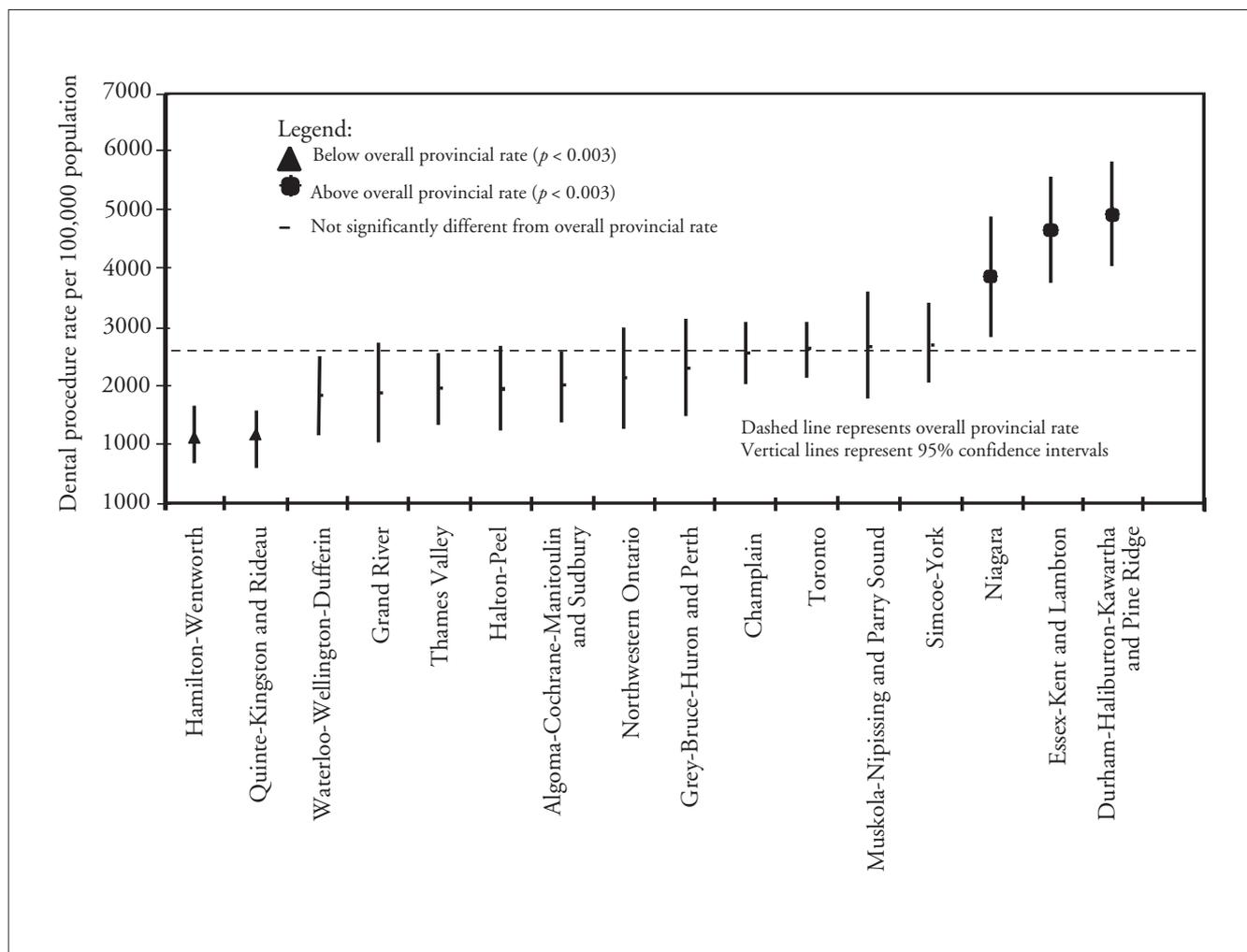


Figure 1: Variation in the rate of dental procedures by district health council area of Ontario, April 1995 to March 2001.

living in the community. A British study examined differences in oral health care during the relocation of a cohort of people with an intellectual disability from institutions to the community.¹² The use of general anesthesia increased by 4% in this group. This may be indicative of a wish by dental clinicians to avoid real or perceived behavioural problems. In Canada, a study conducted at Ontario's largest facility for people with an intellectual disability judged that only 5% of its population required general anesthesia because they were rated as extremely uncooperative.³ On the other hand, of 1,010 people with a diagnosis of mental retardation seen at a hospital-based dental program for those with disabilities in Toronto, over 50% received a general anesthetic.⁷ Some authors see this as evidence that lack of adequate training and experience among general dental practitioners in the community has led to inappropriate referrals for dental treatment under general anesthesia.²² The authors of the latter study⁷ demonstrate that the main criteria for patient selection in the hospital-based program for dental procedures are behavioural rather than medical. This is particularly so among those with intellectual disabilities or mental

retardation. They point out that 80.9% of the patients with mental retardation they saw had severe behaviour problems.

There is published evidence that dentists working in community clinics are reluctant to treat people with an intellectual disability. A study in Florida surveyed caregivers of those with an intellectual disability living in group homes²³; 40% of caregivers experienced difficulty locating dentists willing to provide comprehensive dental services for residents. The caregivers reported that 75% of the residents were cooperative dental patients. Despite this finding, dentists were reluctant to provide services for a variety of reasons, including financial disincentives, inadequate knowledge and training, and a lack of proper equipment necessary to treat this population. A survey of dentists in Simcoe County was conducted in 1986 to evaluate the accessibility and availability of dental care for "special" populations.²⁴ Results showed that only half of dentists surveyed were willing to treat "mentally handicapped" people. In the past, specialized oral care for this population was provided at the institution where they lived or at a

private office by a dentist with experience dealing with this population.⁴

It has been suggested that the oral health of this population has deteriorated since deinstitutionalization, due to lack of access to comprehensive oral care; others are of the opinion that an alternative level of care should be provided for this population to ensure comprehensive preventive and curative oral health care.^{4,25,26} Recommended models recognize the need for a team approach (experienced dentist, hygienist, nurse, social worker) and the integration of service sectors (developmental service agencies, private dental practitioners, general hospitals) in a comprehensive program (prevention, referral, restoration). Such programs could decrease the need for day-surgery admissions for dental procedures for this population.

Rates of in-hospital dental procedures vary considerably across the province. This is apparent in the high values for the summary measures of regional variation (extremal quotient 4.4, coefficient of variation 43.6, SCV 153.2). The Institute for Clinical Evaluative Sciences calculated the same measures for various procedures. In the general population, carotid endarterectomy has the highest values (extremal quotient 5.1, coefficient of variation 31.3, SCV 144.3).²⁷ Except for the extremal quotient, these values are lower than the results from this study for dental procedures. Three areas (Niagara, Essex-Kent and Lambton, Durham-Haliburton-Kawartha and Pine Ridge) had dental procedure rates significantly higher than the overall Ontario rate ($p < 0.001$); conversely, 2 areas (Hamilton-Wentworth, Quinte-Kingston and Rideau) had dental procedure rates significantly lower than the overall Ontario rate ($p < 0.001$).

There are a number of possible explanations for the regional variation. People with an intellectual disability living in certain areas of Ontario may have a greater need for services provided at day-surgery facilities. For instance, there may be a higher incidence of people with difficult behaviours in certain parts of the province. The extent to which preventive practices are used in a district health council area could also explain the regional variation. The International Association for the Scientific Study of Intellectual Disabilities has published health guidelines for adults with an intellectual disability.²⁸ The guidelines recommend that those with an intellectual disability and active disease or at high risk for dental disease should make dental visits for oral examinations and prophylaxis every 3 months. Under the current provincial dental plan, basic coverage for people with an intellectual disability allows for visits every 9 months. Another possible explanation for the variation in dental procedure rates is that some areas may have dental care programs that provide more appropriate community-based dental care for people with an intellectual disability. Such a program was introduced in the Waterloo area and may explain the lower rate of dental

procedures done in hospitals there.⁴ Further research is needed to identify the reasons for the significant variation in dental procedure rates across the province and determine whether the oral health care for this population is equitable.

Limitations of the Method

This study had limitations that may have affected the results: limitations associated with the use of routinely collected hospital admission data; identification of people with an intellectual disability from hospital records; the exclusion criteria used in rate calculation; the use of events rather than people; and the summary measures used to assess regional variation. An earlier paper¹⁶ describes the first 3 limitations in depth; here we focus on the last 2 factors.

Consistent with measures of regional variation in the literature, the study refers to counts of events rather than people in calculating rates.^{20,21,27} Some authors contend that this is appropriate only in situations where a person can be included in the numerator at most once, otherwise the rate cannot be considered a proportion.²⁹ For this reason, dental procedure rates may be inflated, but they permit comparisons with results for the general population. Some authors feel that the significance level of chi-squared tests used in regional variation studies should not only take into account multiple comparisons but also the number of admissions for the same person in a given year.³⁰ This study set the significant p -value level at 0.003 to take into account multiple comparisons, but frequently found results significant at $p < 0.001$.

This study used 3 different summary measures to assess regional variation, despite conflicting views about their use.^{20,21,27,31} The extremal quotient is frequently reported and easy to interpret. Its drawback is that it depends only on the 2 most extreme rates, both of which may be outliers resulting from small sample sizes.^{20,27,32,33} The coefficient of variation is based on rates in all areas, but may have overestimated the variation when rates are low or when the area population is low. For these reasons, the SCV was developed; this coefficient permits comparisons between areas with different population sizes and wide rate ranges by removing the component of variation attributed to population size.^{20,21} The problem with the SCV is that the value it generates has no intuitive meaning, there is no statistical test to see if it is significant and it is difficult to assess its public health importance.³³ SCV values from general population studies can be used as a benchmark for comparison. The highest SCV values from Ontario hospital data between April 1992 and March 1994 were 144.3 for carotid endarterectomy and 78.6 for coronary artery bypass surgery.²⁷ Also 95% CIs are presented along with a chi-squared test to evaluate statistical significance (Table 1).

Conclusions

The use of day surgery and in-hospital visits to treat the dental diseases in people with an intellectual disability varies considerably by region in Ontario. The reasons for this are unclear. The prevalence of dental disease among this population may vary by region or some regions may be providing more appropriate community-based dental care. This would lead to improved access and less reliance on costly hospital-based care. People with an intellectual disability are entitled to the same level of excellence in dental care throughout Ontario. A clear understanding of the reasons for the apparent disparity requires immediate attention. ♦

Acknowledgements: Sources of support: Ontario Graduate Scholarship Program, 2000–2001; Educational Associateship, Developmental Consulting Program, 1999–2000; The Healthcare Equity for Intellectually Disabled Individuals (HEIDI) Health Care Access Subgroup through a grant received from the Canadian Institutes of Health Research to J.A. Holden, S. Lewis, N. Garcin, H. Ouellette-Kuntz, P. Minnes, Y. Lunsley, B. McCreary, C. Forster-Gibson, D. Hunter, E. Rajcan-Separovic, E. Bradley, B. Hennen, 2003.

We acknowledge the contribution of the Canadian Institute for Health Information, which made data available through the Graduate Student Data Access Program. The Ontario Ministry of Community, Family and Children's Services provided information from the Comprehensive Income Maintenance System database. Although parts of this material are based on data and information provided by these 2 agencies, the analyses, conclusions, opinions and statements expressed herein are those of the authors and are not necessarily those of the Canadian Institute for Health Information or the Ontario Ministry of Community, Family and Children's Services.

We are grateful for the insights provided by Dr. Richard Gresik, a community dentist, who reviewed and provided comment on a draft of the manuscript.



Mr. Balogh is physiotherapist and clinical education coordinator, International Centre for the Advancement of Community-Based Rehabilitation, Queen's University, Kingston, Ontario.



Ms. Ouellette-Kuntz is epidemiologist at Ongwanada, a community-based organization for people with an intellectual disability; and assistant professor in the departments of community health and epidemiology and psychiatry, Queen's University, Kingston, Ontario.

Dr. Hunter is assistant professor in the department of community health and epidemiology, Queen's University, Kingston, Ontario.

Correspondence to: Ms. Hélène Ouellette-Kuntz, Department of Community Health and Epidemiology, Queen's University, c/o Ongwanada, 191 Portsmouth Ave., Kingston ON K7M 8A6. E-mail: oulette@post.queensu.ca.

The authors have no declared financial interests.

References

1. Developmental Services Act, R.S.O. 1990, c. D.11. Available from: URL: <http://www.canlii.org/on/laws/sta/d-11/20040802/whole.html>.
2. Ouellette-Kuntz H, Paquette C. The prevalence of developmental disabilities in Lanark County, Ontario. *J Developmental Disabilities* 2001; 8(1):1–16.
3. Girgis SS. Dental health of persons with severe mentally handicapping conditions. *Spec Care Dentist* 1985; 5(6):246–8.
4. Richardson BA, Atkins RD. Normalization of dental care for handicapped patients in a medium-sized Canadian city: a team approach. *J Can Dent Assoc* 1982; 48(6):395–400.
5. Ontario Ministry of Community and Social Services. A discussion paper on a new mental retardation program for Ontario. 1974. Toronto, Ontario, Government of Ontario.
6. Ontario Ministry of Community and Social Services. A new mental retardation program for Ontario. 1974. Toronto, Ontario, Government of Ontario.
7. Hulland S, Sigal MJ. Hospital-based dental care for persons with disabilities: a study of patient selection criteria. *Spec Care Dentist* 2000; 20(4):131–8.
8. Gabre P, Gahnberg L. Inter-relationship among degree of mental retardation, living arrangements, and dental health in adults with mental retardation. *Spec Care Dentist* 1997; 17(1):7–12.
9. Forsberg H, Quick-Nilsson I, Gustavson KH, Jagell S. Dental health and dental care in severely mentally retarded children. *Swed Dent J* 1985; 9(1):15–28.
10. Gabre P, Martinsson T, Gahnberg L. Move of adults with intellectual disability from institutions to community-based living: changes of food arrangements and oral health. *Swed Dent J* 2002; 26(2):81–8.
11. Tiller S, Wilson KI, Gallagher JE. Oral health status and dental service use of adults with learning disabilities living in residential institutions and in the community. *Community Dent Health* 2001; 18(3):167–71.
12. Stanfield M, Scully C, Davison MF, Porter S. Oral healthcare of clients with learning disability: changes following relocation from hospital to community. *Br Dent J* 2003; 194(5):271–7.
13. Hinchliffe JE, Fairpo CG, Curzon ME. The dental condition of mentally handicapped adults attending adult training centres in Hull. *Community Dent Health* 1988; 5(2):151–62.
14. Nunn JH. The dental health of mentally and physically handicapped children: a review of the literature. *Community Dent Health* 1987; 4(2):157–68.
15. Sigal MJ, Levine N, Barsky RL. A survey of a program for the dental care of disabled adults. *J Can Dent Assoc* 1988; 54(2):103–6.
16. Balogh R, Ouellette-Kuntz H, Hunter DJW. Hospital utilization among persons with a developmental disability, Ontario, 1995–2001 [MSc dissertation]. Kingston (ON): Queen's University; 2003.
17. World Health Organization. International classification of diseases. Manual of the international statistical classification of disease, injuries, and causes of death. 9th revision. Geneva, Switzerland: World Health Organization, 1977.
18. Statistics Canada. 1996 Census of Canada. 1997.
19. Spiegelman M. Introduction to demography. Revised edition. Cambridge: Harvard University Press, 1968.
20. Coyte PC, Croxford R, Asche CV, To T, Feldman W, Friedberg J. Physician and population determinants of rates of middle-ear surgery in Ontario. *JAMA* 2001; 286(17):2128–35.
21. McPherson K, Wennberg JE, Hovind OB, Clifford P. Small-area variations in the use of common surgical procedures: an international comparison of New England, England, and Norway. *N Engl J Med* 1982; 307(21):1310–4.
22. Holland TJ, Lucey S, Kavanagh C, O'Mullane DM. Costs in providing facilities for treatment of handicapped patients under general anaesthesia. *J Ir Dent Assoc* 1997; 43(3):72–5.
23. Burtner AP, Jones JS, McNeal DR, Low DW. A survey of the availability of dental services to developmentally disabled persons residing in the community. *Spec Care Dentist* 1990; 10(6):182–4.
24. Hicks T, Knipe C, Mezenberg W. The accessibility and availability of dental care to ill, elderly and handicapped residents of Simcoe County. A summary of methodology and results of the 1986 survey. *Can J Community Dent* 1988; 3(1):22–31.
25. Burtner AP, Dicks JL. Providing oral health care to individuals with severe disabilities residing in the community: alternative care delivery systems. *Spec Care Dentist* 1994; 14(5):188–93.
26. A position paper from the Academy of Dentistry for Persons with Disabilities. Preservation of quality oral health care services for people with developmental disabilities. *Spec Care Dentist* 1998; 18(5):180–2.

27. Goel V, Williams JI, Anderson GM, Blackstein-Hirsch P, Fooks C, Naylor CE, editors. Patterns of health care in Ontario. The ICES Practice Atlas. 2nd ed. Ottawa: Canadian Medical Association; 1996.
28. Lennox N, Beange H, Parmenter T, Santos-Teachout R, Evenhuis H, Kerr M, and others. Health guidelines for adults with an intellectual disability. International Association for the Scientific Study of Intellectual Disabilities. 2002.
29. Diehr P, Cain K, Connell F, Volinn E. What is too much variation? The null hypothesis in small-area analysis. *Health Serv Res* 1990; 24(6):741–71.
30. Diehr P, Cain KC, Kreuter W, Rosenkranz S. Can small-area analysis detect variation in surgery rates? The power of small-area variation analysis. *Med Care* 1992; 30(6):484–502.
31. Diehr P, Cain K, Ye Z, Abdul-Salam F. Small area variation analysis. Methods for comparing several diagnosis-related groups. *Med Care* 1993; 31(5 Suppl):YS45–53.
32. Kazandjian VA, Dans PE, Scherlis L. What physicians should know about small area variation analysis. *M Med J* 1989; 38(6):477–81.
33. Coory M, Gibberd R. New measures for reporting the magnitude of small-area variation in rates. *Stat Med* 1998; 17(22):2625–34.