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ESTIMATION OF THE UNDER-REPORTING RATE FOR THE SURVEILLANCE OF ESCHERICHIA COLI O157:H7 CASES IN ONTARIO, CANADA

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Summary

Two models estimating the proportion of E. coli O157:H7 cases not reported in the Ontario notifiable diseases surveillance system are described. The first model is a linear series of adjustments in which the total number of reported cases is corrected by successive under-reporting coefficients. The structure of the second model is based on a relative difference in the proportion of E. coli O157:H7 cases which are hospitalized between the surveillance database and the underlying population.

Based on this analysis, the rate of under-reporting of symptomatic cases of E. coli O157:H7 infection in Ontario ranges from 78 to 88 % corresponding to a ratio of 1 reported case for approximately 4 to 8 symptomatic cases missed by the surveillance system. This study highlights the need to increase awareness among public health workers of the potential biases that may exist in the interpretation of routine surveillance data.

INTRODUCTION

In any surveillance system, the processes of detection, confirmation and reporting of cases are critical activities which greatly influence our capacity to accurately evaluate the impact of a given disease in a population. The ability of such a system to detect all possible cases occurring in a population is referred to as the sensitivity of the surveillance system. In the case of E. coli O157:H7 surveillance, this sensitivity is influenced by many factors, including the likelihood that an infected patient will seek medical attention, the proportion of those patients for which an appropriate laboratory test will be requested, the ability of the testing process to confirm true cases and the subsequent successful relaying of the patient's medical information through the reporting system.

Estimation of the under-reporting rate requires the collection of information external to the system to determine the most likely true occurrence of the disease in the population of interest. This can be achieved using two different strategies: (a) evaluating the disease frequency with an independent epidemiological study including a representative sample of the underlying population and (b) estimating correction factors for each element of the surveillance system to adjust observed frequencies for the likely under-reporting bias.

Estimation of a correction factor for each step in the surveillance process was central to a study conducted by Chalker and Blaser in 1988 to evaluate the under-reporting of salmonellosis in the United States.[1] Inspired by a surveillance model described for shigellosis [2], the surveillance artifact model proposed by these authors consisted of the evaluation of seven steps involved in the process of detection and reporting of patients infected with salmonella. Based on a comprehensive review of the medical literature related to the parameters associated with each step, the true incidence of salmonellosis was estimated using a sequence of correction factors applied to each of these steps. The principal limitation of this approach lies in the amount of uncertainty attached to the value of the correction factors. In their calculation of the incidence of salmonellosis, Chalker and Blaser used a point estimate, the median, to calculate a correction factor for each step and the overall correction factor for the model. Their sequential model was deterministic in nature and no provision was made to calculate measures of variation around the point estimate.

Surveillance for E. coli O157:H7 infection in Ontario can also be modelled using linear sequential steps of detection and reporting. At present, there is no published information regarding the magnitude of under-reporting associated with surveillance for E. coli O157:H7 in the Province. Lacking such information, public health workers have often assumed the extent of E. coli O157:H7 under-reporting to be approximately the same as for salmonellosis or comparable to estimates derived for undifferentiated gastroenteritis.[3-6]

The principal objective of the present study was to provide an estimate of the under-reporting rate for E. coli O157:H7 infection under the surveillance system in place for the Province of Ontario, Canada. To better appreciate the stochastic nature of variables describing the surveillance process, values for the correcting

factors were obtained using simulation models which considered a probability distribution for each coefficient in the models and allowed the calculation of standard errors associated with the under-reporting estimates. In addition to a sequential model, a novel method, based on hospitalization rates, was used to validate the magnitude of the under-reporting estimate.

MATERIALS AND METHODS

Data sources

Information on the 2,971 verocytotoxigenic Escherichia coli (VTEC) cases reported in Ontario between 1990 and 1995 was extracted from the Reportable Disease Information System database (RDIS) from the Ministry of Health of Ontario. Health services for residents of Ontario are paid for through a publicly funded universal health care system administered by the Province. The mean provincial population over the time period of interest was 10,084,885. Sporadic cases of VTEC were defined as persons with compatible clinical signs for which one or more of the following criteria applied: verocytotoxin was detected from stool specimens; one or more strains of verocytotoxigenic Escherichia coli was isolated from stool or blood. Outbreak related cases (n = 94) and VTEC cases other than E. coli O157:H7 (n = 5) were excluded from the study (n = 2,872 selected cases).

Systematic literature review and coefficient estimation

Two simulation models, referred to as sequential and hospital models, were used for the estimation of the rate of under-reporting of E. coli O157:H7 in Ontario. Estimation of the coefficients entering the models were derived from a comprehensive literature review of outbreak reports and surveillance studies on E. coli O157:H7 infection. All North-American and European reports published between 1980 and 1995 and describing the clinical and/or epidemiological characteristics of E. coli O157 cases for outbreaks or sporadic cases were considered for inclusion in the study. From these, studies and reports for which case definitions of E. coli O157 were ill-defined, for which the total population exposed was not estimated, or for which the underlying population was not defined were excluded. Scientific articles which reported information on under-reporting associated with undifferentiated gastroenteritis were also searched. The literature search was conducted using Medline (National Library of Medicine) and Current-Contents (Institute for Scientific Information, Inc. 1993) and by consulting with recognized experts in the field. The bibliographies of articles identified in this manner were systematically reviewed to identify additional relevant references. Relevant information was extracted from the selected articles and compiled into a spreadsheet program (Lotus 123; Lotus Development Corporation, Georgia).

The appropriate distributions were selected for the coefficients entering the models based on the values reported in the literature as well as on the amount of uncertainty attached to each of these values.

Sequential model

In the sequential model, the series of events necessary for E. coli O157:H7 infection to be detected and reported was modelled using six variables. The first variable (α) was an estimate of the proportion of the total number of infected people who are symptomatic. The second variable (β) estimated the proportion of symptomatic cases who seek medical attention. The third variable (γ) estimated the total proportion of symptomatic patients for whom a stool sample is requested for confirmation of E. coli O157:H7. The fourth variable (δ) estimated the proportion of these samples which are laboratory-confirmed. The fifth variable (ε) estimated the proportion of laboratory-confirmed cases which are reported to the appropriate health authority. The last variable "n" consisted of the annual average number of E. coli O157:H7 cases recorded in the RDIS database over the time period of interest. The proportion of the total population infected with E. coli O157:H7 not reported in the surveillance database ($UR_{population}$), and the proportion of the symptomatic cases of E. coli O157:H7 not reported in the surveillance database (UR_{sympt}) were calculated using equations (1) and (2) in Appendix 1.

Hospitalization model

Another approach based on the proportion of cases hospitalized was developed to estimate the under-reporting rate of E. coli O157:H7 in Ontario. The hospitalization model relied on the assumptions that hospitalized cases recorded by the surveillance database were symptomatic, were seen by a physician and a stool sample was taken for laboratory identification and confirmation. Under these circumstances, the under-estimation of symptomatic cases of E. coli O157:H7 is reflected by the unknown fraction of two groups; the non-hospitalized and hospitalized E. coli O157:H7

cases. As in the sequential model, the number of reported hospitalized cases was assumed to be dependent on the proportion of the cases which are laboratory confirmed (δ coefficient) and the extent to which laboratory-confirmed E. coli O157 cases were reported by laboratories and hospitals to the Ontario Ministry of Health (ε coefficient). The under-reporting rate (UR_{sympt}) was calculated by taking the ratio of the hospitalization rate based on the RDIS surveillance database (X) to the hospitalization rate occurring in the general symptomatic population of cases (Y). The estimated general hospitalization rate was derived from a comprehensive literature review of outbreak reports and surveillance studies on E. coli O157 infection. The under-reporting rate (UR_{sympt}) based on that model was calculated using equation (3) in Appendix 2.

Analyses

Computations were performed using a risk analysis software (@RISK, Palisade Corporation, New York). Probability distributions for the expected number of people with E. coli O157:H7 infection, the expected number of symptomatic cases, under-reporting rates and ratios of reported to unreported cases for both models were generated based on 10,000 iterations in a Monte-Carlo re-sampling procedure.

RESULT

A. Sequential model

Proportion of E. coli O157:H7 infected people who are symptomatic (α)

Prior investigations have demonstrated that E. coli O157:H7 can cause a spectrum of illnesses which includes non-bloody diarrhoea, HUS and asymptomatic carriage.[7-10] One estimate of the overall proportion of asymptomatic infections for a given population can be derived from outbreak investigation data. In a small community outbreak in south-east Scotland, six cases were identified on the basis of stool culture, from which one (16.6%) was reported asymptomatic.[11] In 1986, Duncan and collaborators [12] described an outbreak in a kindergarten class in Ontario. They reported 43 out of 62 children had symptoms and 10 out of the remaining 19 were asymptomatic but showed laboratory evidence of infection, giving an approximate asymptomatic proportion of 10/53 (18.8%). In an outbreak of hemorrhagic colitis where 17 persons had confirmed infection, 4 (23.5%) were asymptomatic.[13] More recently in a Minnesota child day-care outbreak, six of 38 individuals (15.8%) met the case definition but were reported to have no symptoms.[14] From 20 cases of confirmed E. coli O157 detected in a three year survey conducted in one laboratory in Brussels, absence of any gastro-intestinal symptoms was reported in two (11.1%) patients.[15] During a laboratory survey in Wales (1990 -3), 147 cases of E. coli O157 were detected, from which 18 percent were reported to be asymptomatic.[16] Considering the above information, a triangular distribution with a minimum value of 11%, a most likely value of 18 % and a maximum value of 24 % was chosen for the proportion of asymptomatic people infected with E. coli O157 (α). The proportion of E. coli O157 infected people who are symptomatic (α) was calculated as $1 - \alpha$.

Symptomatic cases self-reporting to a physician (β)

Information regarding E. coli O157:H7 patients seeking medical attention is very limited. To our knowledge, only the study by Swerdlow and colleagues [17] describing a waterborne outbreak of E. coli O157:H7 in Missouri contained an explicit assessment of the proportion of affected patients who sought medical attention. In this article, the authors reported that 40 out of 55 E. coli O157:H7 patients with bloody stool (73%) reported to the medical authorities, and 11 out of 50 with non-bloody stools (22%) responded the same way (overall proportion 49%). In an analysis of the costs associated with E. coli O157:H7 infection by Marks and Roberts[18], the authors assumed that about half of all cases seek medical attention. Their choice of this coefficient (higher than for salmonella infection) was supported by the increased likelihood of patients to see a doctor in the presence of bloody diarrhoea which occurred in approximately 45 % of all E. coli O157:H7 cases (Table 1).

Studies containing self-reporting estimates in cases of unspecified enteric illness or food borne disease are also available. In Great Britain, the results of a survey by the Ministry of Agriculture, Fisheries and Food (MAFF) revealed that only 17% of respondents who experienced suspected food poisoning reported the incident to medical authorities.[19] Following an episode of water contamination with sewage in Ireland, only 22 % of 340 cases with clinical signs of enteric illness (diarrhoea, vomiting or abdominal cramps) visited their general practitioner.[5] In another study, approximately 20% of patients with gastrointestinal

Table 1
Proportion of E. coli O157 cases with bloody diarrhoea in selected studies of E. coli O157 infection

Outbreaks	Total	Bloody diarrheoa No. (%)	Ref.
1982, Ontario	31	20 (64.52)	(10)
1984, Nebraska	34	19 (55.88)	(27)
1984, North Carolina	36	11 (30.56)	(28)
1985, Ontario	18	5 (27.78)	(29)
1985, Ontario	55	41 (74.55)	(29)
1988, Minessota	38	22 (57.89)	(14)
1988, Minessota	54	31 (57.41)	(30)
1990, Missouri	243	86 (35.39)	(17)
1992, Germany	39	11 (28.21)	(31)
1994, Virginia	20	7 (35.00)	(32)

diseases had consulted a general practitioner, independent of the degree of severity of the symptoms.[4] Considering this information, a triangular distribution with a lower limit of 17%, an upper limit of 73% and a most likely value of 50% was chosen for this coefficient (β).

Proportion of symptomatic cases for whom stool samples are obtained (γ)

We found no report in the literature presenting direct information regarding the proportion of symptomatic cases of E. coli O157:H7 infection for which a stool sample was requested by a medical authority. In their report concerning the sporadic occurrence of hemorrhagic colitis associated with E. coli O157:H7 in Newfoundland, Ratnam and March 20 wrote "All seven patients whose specimens were positive for E. coli O157:H7 had clinical manifestations typical of hemorrhagic colitis, but the syndrome was clinically suspected and a specific test requested in only two cases." In this case, the relevant estimate would be equal to 29% (2/7).

Similar estimates have been derived for other enteric illnesses. In their review, Chalker and Blaser [1] gave an overall estimate of 41.66% (median) calculated from five salmonella and shigella investigations in which 24, 32, 42, 66, and 86% of patients had stools requested for examination. In Great Britain a survey of people reporting to a physician with diarrhea showed only 5.4% as having stool requested for examination.[21] Considering the above information, a triangular distribution with a lower limit of 5%, an upper limit of 85% and a most likely value of 42% was chosen for this parameter.

Sensitivity of the laboratory procedures (δ)

In 1988, Kleanthous and colleagues published a study evaluating the use of sorbitol MacConkey agar (SMAC) in conjunction with serotyping when compared to a DNA probe specific for the genes encoding for verocytotoxins 1 and 2.[22] The results of this study indicated a sensitivity of 62 and 56% for the identification of E. coli O157 cases using SMAC and serotyping in patients with bloody diarrhoea and non-bloody diarrhoea, respectively. The specificity of the routine test procedure using SMAC and serotyping was 100% for both groups. However, similar data (sensitivity and specificity) concerning the use of SMAC and serotyping for groups of cases with all levels of disease severity, including ones with no symptoms, are not currently

Table 2
Sensitivity of isolation and confirmation procedures in selected studies of E. coli O157 infection

Outbreaks	Total	Percent Confirmed	Ref.
1982, Michigan	21	42.86	(33)
1982, Ontario	31	58.06	(10)
1982, Oregon	26	50.00	(33)
1984, Nebraska	34	17.65	(27)
1984, North Carolina	36	26.67	(28)
1985, Ontario	73	42.86	(29)
1985, U.K.	89	35.96	(34)
1986, Ontario	42	67.44	(12)
1986, Washington	37	37.84	(35)
1987, Alberta	17	58.82	(36)
1987, Ontario	15	60.00	(36)
1987, U.K.	26	56.52	(13)
1988, Minessota	54	53.57	(30)
1988, Minessota	38	72.22	(14)
1988, Ontario	25	56.00	(37)
1988, Alberta	63	61.90	(37)
1988, U.K.	49	65.63	(38)
1990, Michigan	243	58.33	(17)
1991, Massachussets	23	17.39	(39)
1992, Germany	39	20.51	(31)
1994, Virginia	20	77.78	(32)
1995, Georgia	10	87.50	(40)
1995, Illinois	12	66.67	(41)

available. Table 2 summarizes the proportion of symptomatic cases of E. coli O157 infection from whom stool samples were obtained and laboratory-confirmed in 21 selected outbreak investigations and one surveillance study. Since the majority of licensed diagnostic laboratories in Ontario routinely screen stool samples for E. coli O157:H7 using Sorbitol MacConkey agar, and since there is a high level of awareness regarding this condition in the Province, we assumed that all submitted samples are tested. Considering the above information, a normal distribution with a mean of 51.8% and a standard deviation of 10.4% was chosen for this coefficient.

Success in reporting to the Ontario Ministry of Health (ε)

Failure to transmit information on confirmed cases to the Ontario Ministry of Health is estimated to be less than 1% in the present surveillance system (H. Lior, National Laboratory for Enteric Pathogen, personal communication). Considering this information, a uniform distribution with a lower limit of 99% and an upper limit of 100% was chosen for this parameter.

Average number of E. coli O157:H7 cases recorded in RDIS during one year (n)

The average number of E. coli O157:H7 cases reported yearly by the surveillance system was estimated by the mean annual number of cases recorded in the RDIS surveillance database between 1990 and 1995. A normal distribution with a mean of 478.7 (years per 100,000 population) and a standard deviation of 71.8 was calculated for this variable.

Simulation results for the sequential model

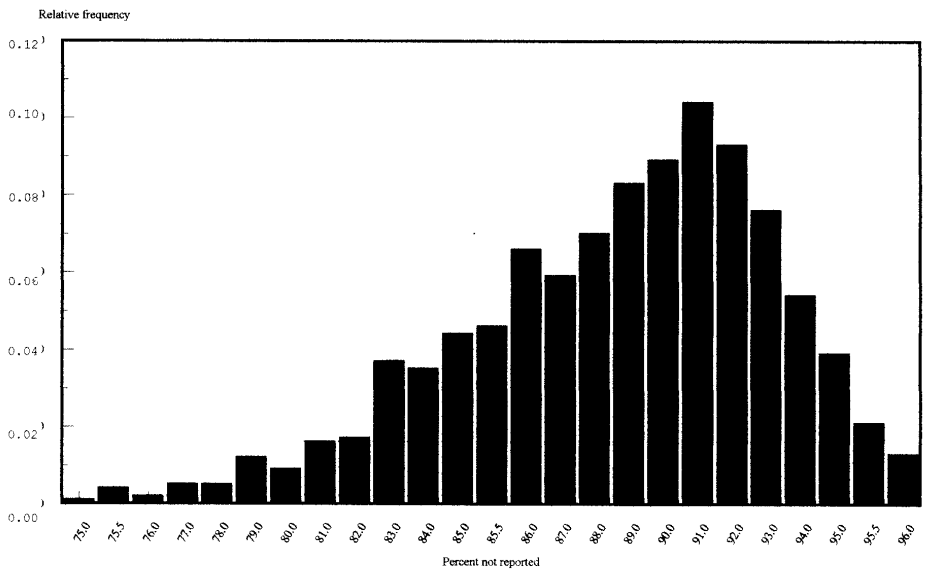
The distribution of the expected total number of people with E. coli O157:H7 infection for Ontario was slightly skewed to the right with a mean of 5,791 cases (53.9 cases per 100,000 population). Under this model, the expected number of people with E. coli O157:H7 infection in Ontario would range from 1,296 to more than 33,564 per year. The distribution of the proportion of all people with E. coli O157:H7 infection who are unreported had a mean of 90.0% while the mean of the distribution of the ratio of reported to unreported cases was approximately 1 to 11. The distribution of the total number of symptomatic E. coli O157:H7 cases had a similar shape to that for the total number of E. coli O157:H7 infected people. The annual mean number of symptomatic cases expected under the model was 4,764 (44.3 cases per 100,000). The mean of the distribution of the proportion of symptomatic cases not reported was 87.9% and that of the distribution of the ratio of reported to unreported cases was approximately 1 to 2 (Figure 1).

B. Hospitalization model

Hospitalization rate

The annual hospitalization rate for E. coli O157:H7 cases reported in RDIS (X) was assumed to be normally distributed with a mean annual rate of 53.9% (S.D. = 1.6%) which corresponded to the overall proportion of E. coli O157:H7 cases that necessitated hospitalization between 1990 and 1995.

Figure 1 Predicted proportion of symptomatic VTEC cases which are not reported based on the sequential model, Ontario (1990 - 1995)



Values obtained from the literature were used to estimate the overall population hospitalization rate for E. coli O157:H7 cases. An overall hospitalization rate (Y) of 24.2% (S.D. = 1.1%) was calculated from the hospitalization rates of 23 outbreak investigations from 1982 to 1995 (Table 3). Based on this information, a normal distribution with a mean of 24% and a standard deviation of 1% was chosen for this parameter.

Table 3
Hospitalization rates in selected studies of E. coli O157 infection

Number Outbreak	Number Hospitalized	Hospitalization Rate	Ref.
1982, Michigan	14	66.7	(33)
1982, Ontario	4	12.9	(10)
1982, Oregon	19	73.1	(33)
1984, Nebraska	14	41.2	(27)
1984, North Carolina	3	8.3	(28)
1986, Ontario	3	7.1	(12)
1986, Washington	17	45.9	(35)
1987, Ontario	4	26.7	(36)
1987, U.K.	6	23.1	(13)
1987, Utah	8	15.7	(45)
1988, Minessota	4	7.4	(30)
1988, U.K.	19	38.8	(38)
1988, WI	2	3.3	(46)
1990, Michigan	32	13.2	(17)
1990, North Dakota	16	24.6	(46)
1991, Massachussets	6	26.1	(39)
1993, California	14	41.2	(43)
1993, Idaho	4	28.6	(43)
1993, Nebraska	9	15.5	(43)
1993, Washington	144	30.2	(43)
1994, Virginia	3	15.0	(32)
1994, Washington	3	15.0	(44)
1995, Ilinois	3	25.0	(41)

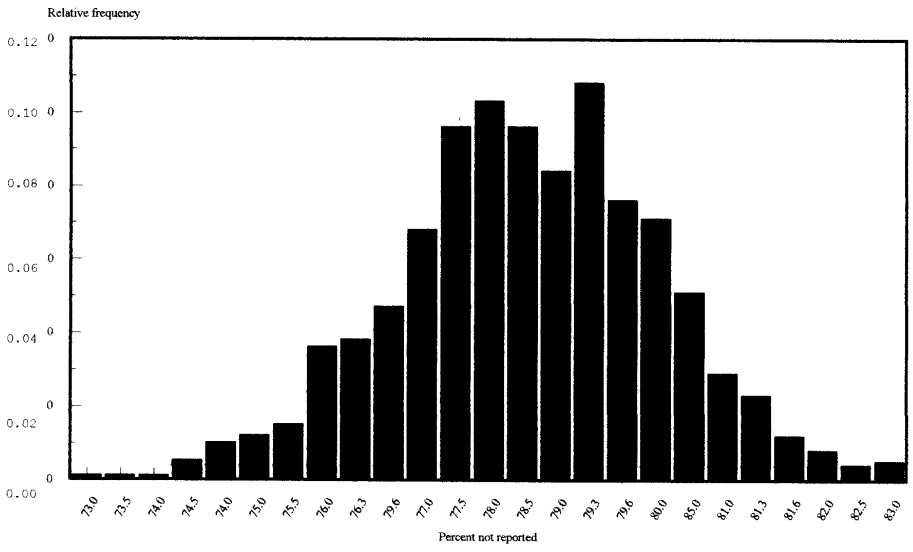
Simulation results for the hospital model

Under the input conditions specified for the coefficients and their distributions, the resulting distribution of expected total E. coli O157:H7 cases for Ontario was approximately normal with a mean of 2,201 per year (20.5 per 100,000 population). The proportion of symptomatic E. coli O157:H7 cases which are not reported was also approximately normally distributed with a mean of 78 % (Figure 2). The corresponding mean of the distribution of the ratio of reported to unreported cases was approximately 1 to 4.

DISCUSSION

Despite the two distinctive methodological approaches used, the results of the present study suggest comparable estimates of the proportion of E. coli O157:H7 cases which are not reported in the Ontario surveillance system. According to our analysis, under-reporting of symptomatic cases of E. coli O157:H7 infections in Ontario ranges between 78 and 88%. This means that, on average, for each E. coli O157:H7 case reported to the Ontario Ministry of Health, approximately 4 to 8 other symptomatic cases are missed by the surveillance system. We also estimated that 90% of the total number of people infected with E. coli O157:H7, including those who were asymptomatic, were not reported in the provincial surveillance database. These estimates were lower than the 95 to 99 % under-reporting rates previously estimated for Salmonella infection [1], or for gastroenteritis in general.[3,21] This lower percentage of unreported E. coli O157:H7 infection can be explained in part by the relatively high proportion (45%) of E. coli O157:H7 infections associated with bloody diarrhoea, which influences the level of reporting in two ways. First, the presence of blood in the stool may be a major reason for individuals to report to a physician.[9] This was shown by the study of Swerdlow and colleagues (17) in which the proportion of E. coli O157:H7 patients with bloody diarrhoea reporting to medical authorities was more than three times greater than for patients with non-bloody diarrhoea. Secondly, bloody stool is one of the principal reasons for physicians to collect stool samples and submit them for microbiological analysis.[6] The occurrence of asymptomatic infection is likely to be influenced, in part, by the level of immunity in the population under study. For this, and other reasons, our estimates of the under-reporting of asymptomatic E. coli O157:H7 infection may not be directly applicable to populations outside Ontario.

Figure 2 Predicted proportion of symptomatic VTEC cases which are not reported based upon the hospital model, Ontario (1990 - 1995)



in the stool specimen submitted. The brief period of time that E. coli O157:H7 organisms are shed as well as the low number of organisms excreted have been suggested as reasons to explain the difficulty in recovering and identifying E. coli O157:H7 from stool specimens.[8,9,23] Hence, further development and utilization of sensitive, rapid and accurate tests for the detection and confirmation of E. coli O157:H7 infection combined with early testing of suspicious cases would appear to be important elements in improving the discovery/reporting rate for E. coli O157:H7 cases.

The main limitation associated with the sequential reporting model relates to the uncertainty around the coefficients used. Estimates of the proportion of symptomatic E. coli O157:H7 patients self-reporting to medical authorities and the proportion of those cases for which a stool sample was requested were particularly problematic in this regard. Similarly, differences in case definitions between reported outbreaks introduces variability into the estimates produced by the simulation models. A value of the Monte Carlo simulation approach is that it allows for incorporation of uncertainty around the input variables into the modelling process. It is important to note that the outputs of the models (eg. under-reporting rates) are also uncertain and are thus expressed as probability distributions, not point estimates (Figures 1 and 2).

Another factor found to have considerable influence on the proportion of E. coli O157:H7 cases reported was the overall sensitivity of the laboratory procedures to identify and confirm true E. coli O157:H7 cases. In spite of considerable improvement in the laboratory methods for detection of E. coli O157:H7 and other VTEC since the early 1980's, approximately 50% of suspected cases could not be confirmed either by isolation of the organism or the detection of verocytotoxin activity

Few important assumptions influence the validity of the hospitalization-based method for estimating the overall under-reporting rate of E. coli O157:H7 infection. The first relied on an accurate estimation of the proportion of E. coli O157:H7 cases which were hospitalized. We derived this estimate from the RDIS database; however, the descriptive analysis of this database revealed a high percentage of missing values associated with the hospitalization status (missing values = 59%).[24] In the present study, estimation of the hospitalization rate from the RDIS surveillance data was calculated under the assumption that the likelihood of observing a missing value in the hospitalization field was independent of the true underlying hospitalization status. Nonetheless, the level of hospitalization calculated from the Ontario surveillance data under this assumption coincides with the estimated proportion of E. coli O157:H7 cases hospitalized from other surveillance and hospital-based studies thus supporting the validity of this assumption.[9,25,26] Secondly, differential estimation of the proportion of cases hospitalized from the RDIS data and the general E. coli O157:H7 population is the central concept of the hospitalization model. The proportion of patients hospitalized in the general E. coli O157:H7 population

was assumed to be equal to the same parameter estimated from outbreak investigations in which, in most cases, the total number of symptomatic people can be evaluated with reasonable accuracy. Patients suffering from milder enteric symptoms and those with more severe clinical signs were all considered in the estimation of the overall hospitalization rate calculated from outbreak situations. In this context, the average of 24% of outbreak-origin E. coli O157:H7 cases admitted to the hospital should reflect closely the true proportion of patients hospitalized in the general population of cases of E. coli O157:H7 infection. Finally, this estimate is derived under the assumption that all hospitalized E. coli O157:H7 cases had symptoms of gasteroenteritis which prompted the collection of a stool specimen for laboratory analysis. This assumption would result in the exclusion of hospitalized E. coli O157:H7 cases having other diagnoses (e.g. stroke, tromboembolic purpura), and for which no such specimen was collected. The term "symptomatic" as it relates to this under-reporting estimate should be interpreted accordingly.

Under-reporting reflects a practical limitation of a surveillance system to detect and report all disease events occurring in the target population. Nonetheless, a surveillance system that has less than perfect sensitivity is still useful in evaluating patient, temporal and geographical characteristics of a disease, provided that its sensitivity remains reasonably constant over time. Factors such as an increased awareness of the disease, the use of new diagnostic procedures, or the modification of surveillance methods can change the sensitivity of the system and must be considered when investigating long-term trends in disease occurrence.

Routine surveillance for notifiable diseases can be invaluable in the detection of disease outbreaks and sporadic cases, the identification of high risk populations and trends in disease incidence, and in the identification of disease risk factors. However, modelling exercises such as this illustrate the practical limitations that under-reporting of cases imposes on the usefulness and interpretation of surveillance data. These studies not only provide estimates of the extent of under-reporting, but also can provide insight into the mechanisms by which under-reporting can occur. To enhance the validity of interpretation of surveillance data, public health workers should be made aware of the potential biases associated with these data, as well as their likely magnitude and direction.

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❑

SOURCE

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DISEASE CONTROL SERVICE COMMENT

Disease reporting is useful in describing the disease status of a population as well as assisting with decision making for health program planning. In general, reporting systems do not capture every case of disease. For most diseases, the cost-benefit ratio of capturing every disease would be exceedingly high.

Michel's article describes a sequential model created with four variables that were considered to be links where constraints could occur in the chain of reporting symptomatic cases. Estimates for these variables based on a literature review indicate that the bulk of constraint to reporting symptomatic cases occurs at the links "Symptomatic Cases Self-Reporting to a Physician", "Proportion of Symptomatic Cases for Whom Stool Samples Are Obtained", and "Sensitivity of the Laboratory Procedures".

Health units are primarily involved with the link "Success in Reporting to the Ontario Ministry of Health". Michel's article estimated the failure to transmit information on confirmed cases of E.coli O157:H7 to be less than 1%. While this statistic for E. coli is very good, there are other organisms that are more difficult to report. For example, the sensitivity of the Reportable Diseases Information System (defined as the ability of the Reportable Disease Information System to capture a case identified by the Central Public Health Laboratory) for cases of Salmonella typhimurium DT 104 was approximately 70%.[1] The sensitivity was low largely due to misclassification of salmonella serotypes at the point of data entry.

In conclusion, Michel's article makes the assumption that success in reporting E. coli to the ministry is good and has little impact on the entire reporting process. The reporting rate may not be as high for other diseases, however. For disease modeling to estimate the true number of cases in the population, it is important that the reporting rate remains stable over time so that bias in the model remains predictable and precise. Constant attention to proper reporting is of paramount importance in order that summary information derived from the data is as close to the "truth" as possible.

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Appendix 1

Calculation of the rate of under-reporting in the sequential model

N = total number of E. coli O157:H7 infected people expected in the population
N' = total number of symptomatic cases of E. coli O157:H7 infection expected in the population
n = average yearly number of symptomatic and asymptomatic cases of E. coli O157:H7 infection reported in the Reportable Disease Information System (RDIS)
n' = average yearly number of symptomatic cases of E. coli O157:H7 infection reported in RDIS
α = proportion of E. coli O157:H7 infected people who are symptomatic
β = proportion of symptomatic cases which self-report to medical authorities
γ = proportion of cases seen by physician which are asked for stool sample
δ = proportion of cases with stool sample which are confirmed by laboratory procedures
ε = proportion of laboratory-confirmed cases which are transmitted to the Ontario Ministry of Health

Let $N = \frac{n}{\alpha * \beta * \gamma * \delta * \varepsilon}$ and $N' = \frac{n'}{\beta * \gamma * \delta * \varepsilon}$

and the proportion of the total number of people infected with E. coli O157:H7 which are reported in RDIS is estimated as: P = { n / N }
The proportion of the total number of symptomatic E. coli O157:H7 cases which are reported in RDIS is estimated as: P= = { n= / N' }

From which:

Under-reporting rate = $UR_{(population)} = (1 - \frac{n}{N}) = 1 - (\alpha * \beta * \gamma * \delta * \varepsilon)$ **(1)**

Under-reporting rate = $UR_{(symptomatic)} = (1 - \frac{n'}{N'}) = 1 - (\beta * \gamma * \delta * \varepsilon)$ **(2)**

Appendix 2

Calculation of the rate of under-reporting in the hospitalization-based model

N' = number of symptomatic cases of E. coli O157:H7 infection in the Ontario population
α = number of hospitalized cases of E. coli O157:H7 in the Ontario population
β = number of hospitalized cases in Reportable Disease Information System (RDIS) database
n= = average yearly number of symptomatic cases of E. coli O157:H7 infection reported in RDIS
δ = proportion of cases with stool sample which are confirmed by laboratory procedures
ε = proportion of those laboratory-confirmed cases which are transmitted to the Ontario Ministry of Health

X = hospitalization rate in RDIS database = $\frac{b}{n'}$

Y = hospitalization rate estimated for the population = $\frac{a}{N'}$

Then the proportion of the total number of symptomatic E. coli O157:H7 cases reported in RDIS can be

RDIS can be estimated as: P = $\frac{n'}{N'}$

since P = $\frac{\frac{n'}{b}}{\frac{N'}{b}}$ and b = a * δ * ε, then P = $\frac{\frac{n'}{b}}{\frac{N'}{a*\delta*\varepsilon}} = \frac{\frac{1}{X}}{\frac{1}{Y}*\frac{1}{\delta*\varepsilon}} = \frac{Y}{X}*\delta*\varepsilon$

From which:

Under-reporting $_{(sympt)}$ = 1 - P = $1-(\frac{Y}{X}*\delta*\varepsilon)$ **(3)**

EVERYDAY AND EXOTIC FOOD BORNE PARASITES

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This paper is a brief survey of the everyday foodborne parasites endemic in Canada and exotic foodborne parasites, which may be acquired by the travelling Canadian or be brought into Canada by an immigrant. Special attention will be paid to *Toxoplasma gondii* infection because of its severity in terms of human misery and costs, and to *Cyclospsora cayetanesis* because of its recent appearance in North America.

Parasites have been with us since the beginning of humankind, despite the media's new found attention to them. The protozoan parasites, *Cryptosporidium parvum*, *Giardia lamblia*, and *Entamoeba histolytica* are commonly acquired through water, homosexual activity, or by close personal contact, such as in day-care centres [1], rather than by food. However, in countries where raw human excrement is used as fertilizer, foodborne transmission is undoubtedly higher. Occasionally, reports of protozoan foodborne outbreak reports make their way into the literature, but this is uncommon.[2] In 1997, in Spokane, Washington, 54 people who had eaten at a banquet hall became ill with diarrhea, fever, chills, and headache.[3] *C. parvum* was the culprit, epidemiologically associated with green onions that were not consistently washed during preparation, and were used in the *au gratin* potatoes, romaine salad and pasta. Because protozoan parasites are sparsely distributed in food, recovery and identification are not routinely possible, so foodborne outbreaks go largely undetected.

The most common of the protozoan parasites in Ontario is *G. lamblia* (Table 1). Many infected individuals are asymptomatic, while others may have gas, abdominal cramping, fatigue and diarrhea. Often physicians will choose to treat symptomatic patients while not treating the asymptomatic ones.

Entamoeba dispar is not a pathogen but is morphologically indistinguishable from its close relative *E. histolytica*. It is thought that many laboratory identifications in Canada for *E. histolytica* are really *E. dispar*. However, without knowing, physicians usually choose to treat patients when the report says *E. histolytica*. A rapid test that can distinguish between these two pathogens is awaited.

Endemic helminth infections are rare in Canada. However, *Trichinella spiralis* in underprocessed wild bore meat caused illness in 24 people in southern Ontario in 1993.[4] The wild boar may have acquired the organism by eating undercooked pig slaughterhouse scraps or foraging for rats. One may question what is meant by the term "wild" boar if they were feeding on garbage scraps, rather than roaming free to seek their food. Outbreaks of trichinosis have also been reported from the consumption of raw, fresh horsemeat, which is popular in Europe. Because horses are herbivorous, it is a mystery how they become infected. Carnivores may have been ground up in their hay. Outbreaks in France and Italy from 1975 to 1993, resulted in over 2600 human cases of trichinosis.[5] Imported carcasses, some from the United States and Canada, that were refrigerated, but not frozen, were linked to these outbreaks. Freezing is a reliable method for inactivating trichinae when done at the appropriate temperatures for the required time.

The adult tapeworms, *Taenia solium* and *Taenia saginata*, are acquired by eating undercooked pork or beef, respectively. *T. solium* is the nastier of the two. A person harbouring an adult *T. solium* worm will release worm eggs in their stool. If the person's handwashing habits after toileting are poor, they may unwittingly transmit eggs to others via food that is handled. This may occur within a family, where the eggs, after being ingested, may develop into cystic lesions in the brain. In one case in Boston in 1990, a 16-month old girl had a seizure. A computed tomography (CT) scan revealed several ring-enhancing lesions. Stool specimens from her father contained *Taenia* species eggs.[6] He had undoubtedly eaten undercooked pork sometime previously, likely in the Cape Verde Islands where he had lived before his daughter's birth. Fortunately, pork tapeworm is rare in Canada. *T. saginata* is more common, due to the more common habit of eating undercooked beef than pork. Laboratories cannot distinguish the egg of *T. saginata* from that of *T. solium*, so only the genus is reported. A detailed food history may point to a particular species.

Raw fish may also be a source of parasites. Anisakid worms are occasionally found in raw sea fish, and when consumed, may burrow into the stomach or

Table 1 Parasite isolations from human faecal sample submissions for 1997 in Ontario.

Parasites	**Food of concern**	**Public and private labs***	**LCDC†**
Everyday (endemic in Canada)			
Entamoeba histolytica or *E. dispar*	Nonspecific	1426	1806
Giardia lamblia	Nonspecific	4157	5877
Cryptosporidium parvum	Nonspecific	386	
Taenia saginata/*T. solium*	Beef/pork	111	
Trichinella spiralis	Pork		21
Anisakis/*Pseudoterranova*	Marine fish		
Diphyllobothrium latum	Freshwater fish	20	
Toxoplasma gondii	Meats		
Exotic parasites (imported)			
Cyclospora cayetanensis	Nonspecific	81	
Echinostoma species	Snails		
Heterophyes/*Metagonimus* species	Freshwater fish		
Clonorchis/*Opisthorchis* species	Freshwater fish	69	
Fasciola hepatica	Watercress		
Paragonimus westermanni	Crab/crayfish		
Ascaris lumbricoides	Nonspecific	281	
Trichuris trichiura	Nonspecific	517	

* Compiled from Ontario Public Health Laboratories data (courtesy of Dr Ted Scholten, Chief [Ret] Parasitology), the three largest private laboratories in Ontario, and one smaller laboratory. Isolations may represent multiple submissions from patients and collectively represent about 65% of all laboratories in Ontario.

† Laboratory Centre for Disease Control, Ottawa.

intestine, causing acute pain. With the increasing popularity of sushi in Canada (seaweed wrapped rice topped with raw seafood), one might think that anisakids would be an increasing concern. However, documented cases of anisakiasis in Canada are few [7], unlike Japan where hundreds of cases are reported annually.[8] In Spain, allergic reactions to the dead anisakids have been reported which may be a more significant consequence than having the live parasite.[9] One fish parasite that is reported, albeit infrequently, in Ontario is *Diphyllobothrium latum*, which is acquired by eating undercooked freshwater fish, such as pike. Twenty isolations were made by private and public health laboratories in Ontario in 1997 (Table 1).

T. gondii is the most significant food-borne parasite because it is common, its acquisition can be devastating, and it places an immense financial burden on society. The most likely route of exposure is through consumption of undercooked meat; pork or lamb are more likely to be infected than beef (Table 2).[10] Cattle appear to develop a more effective immune response to *Toxoplasma* than sheep. Additionally, *T. gondii* may be acquired from accidental ingestion of oocysts in cat excrement, by transplant or transplacentally, a potentially devastating consequence. Tizard *et al.* [14] tested 7060 human serum specimens from a cross-section of Ontario residents for antibody to *T. gondii* and found 38% testing positive. As the population ages, the incidence

Table 2 Prevalence of serum antibodies to *Toxoplasma gondii*

Animal species	% positive by antibody titre			
	Tizard et al [10] (Ontario)	Patton et al [11] (southern United States)	Dubey et al [12] (Illinois)	Gajadhar et al [13] (Canada)
Cats	20		68	
House mice	11		2	
Deer mice	5		5	
Finishing pigs	45		2	3.5 - 13
Goats	63	65		
Sheep	65			
Cattle	17			
Rats	3		5	

rises due to increased opportunity for exposure. Rates of seropositivity are known to climb from 2.7% in infants, who have had little opportunity to be exposed to *T. gondii*, to 50% in individuals aged 25 years or older, who have had increased opportunities for exposure.

The congenital form of toxoplasmosis may result in children being developmentally delayed, blind, or deaf. Economic losses primarily result from institutionalization or special education needs of victims. In 1992, Roberts et al. [15] estimated that 4179 cases of congenital toxoplasmosis occur annually in the United States at a cost to society of US $2.4 billion. One could interpolate the American data, using a 1 to 10 ratio, to predict about 400 cases of congenital toxoplasmosis in Canada annually. This is a reasonable estimate because in 1986, Carter and Frank [16] estimated 140 to 1400 cases annually of congenital toxoplasmosis in Canada. Likewise, using 10% of the American cost estimates would place the cost to Canadian society at $240 million annually, no small amount.

Toxoplasmosis in AIDS patients is another concern because the organism may go to the brain, causing toxoplasmosis encephalitis (TE). TE is the second most common AIDS-related opportunistic infection of the central nervous system, and occurs in 10% to 50% of patients with AIDS who are positive by antibody serology to Toxoplasma and have a low CD4+ T lymphocyte count 17. American costs for infected patients' care are estimated at over US$17,000/patient annually.[18] Toxoplasmosis in the AIDS patient is likely a reactivation of latent tissue cysts and not a recent infection, because immunoglobulin G antibodies in patients indicate prior infection.

Food control of *T. gondii* includes cooking meats to at least 66^0 C [19] (better yet cook to 71^0C because that will destroy salmonellae too) or freezing to -12^0 C [20]. Gamma irradiation of meat has been shown to be effective at 0.5 kGy in inactivating tissue cysts of *Toxoplasma*. If consumers are willing to accepted irradiated food, this would appear to be the best strategy because public health efforts are maximized when control is centralized rather than relying on individual behaviour.

Potential solutions for controlling toxoplasmosis in livestock include a live vaccine for sheep, available in New Zealand and the United Kingdom.[21] The vaccine is intended to prevent abortion in sheep. A live vaccine is being developed in the United States for cats to reduce oocyst shedding.

In this discussion, 'exotic parasites', refer to parasites entering in imported foods or brought back by Canadians travelling abroad. *C. cayetanensis* has been in the North American news since 1996, when it was associated with an outbreak arising from importation of Guatemala raspberries.[22-24] Washing raspberries

will not remove all the parasites which may be hiding in nooks and crannies. From 1996 to 1998, there were over 3,000 cases of cyclosporiasis in North America. Raspberries are not the only food vehicle linked to illness; a Florida outbreak involved mesculun lettuce [23] and another outbreak in the Maryland area involved basil in a basil-pesto salad.[25] One of the victims did not even eat the salad but used the serving spoon to serve himself leftovers. This suggests a small infective dose, as does the fact that this is a coccidian parasite (*T. gondii* and *C. parvum* are others), which are infective in small numbers. Although a team of federal investigators travelled from Canada and the United States to Guatemala in the spring of 1998 to investigate, the source of the *C. cayetanensis* was not found. Human sewage from pits near fields or from workers with poor personal hygiene were suspect. Other documented outbreaks, in Nepal and Papua, New Guinea, have occurred from contaminated water.[26] Although coccidia are not destroyed by chlorination, because of their resistant oocyst wall, filtration in municipal treatment plants can capture the 10 µm oocyst of Cyclospora species.

Potential solutions on farms include the use of potable water for spraying crops, workers thoroughly handwashing after using the toilet, and toilet facilities that keep sewage from contaminating the environment. It would also be useful to be able to trace berries back to a particular farm if an outbreak were to occur. Canadians must rely on federal government policy to restrict the sale of imported produce if the produce is 'high risk', eg, produced under unhygienic conditions. Irradiation may be a future alternative if it will not compromise the texture of the berry.

Other, exotic parasites include the flatworms *Echinostoma, Heterophyes, Metagonimus, Clonorchis*, and *Opisthorchis*, which live in intestines or bile ducts. They are usually acquired from eating raw or improperly processed fish, snails or crab in Asian countries (Table1). Some species of *Opisthorchis* in Thailand infect over 90% of the inhabitants in some villages.[27]

Nematodes, roundworms of the intestinal tract, that are transmitted in food, include *Ascaris lumbricoides* and *Trichuris trichiura*. They are not associated with any specific food but are acquired when human sewage contaminates produce that is not cooked. These parasites may pose a medical problem to the infected but not to the public's health because they are not directly infective, needing to mature in soil for one to several weeks. Because of good sewage control in developed countries, through municipal treatment plants and septic tanks systems, the eggs are not disseminated to fertilize produce where they would start the cycle again.

Conclusions

We are fortunate to live in Canada, where we generally have good public health practices such as cooking foods well, municipal water filtration, and sewage disposal, that aid in reducing our exposure to infectious agents. Additionally, we rely on government policy to prohibit importation of foods that may be high risk. Occasionally, however, these systems can fail as this discussion has indicated. We still have room for reducing risk and improving our health.

❑

SOURCE

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TRAVEL ASSOCIATED ENTERIC ILLNESS IN ONTARIO

Introduction

One risk associated with traveling outside of Canada is acquiring an enteric illness. An increase in the number of reported cases of two bacterial enteritides was noted in the period from February to April, 2000. These months coincided with the period when many Canadians travel south for holidays. The increase in cases was determined to have been associated with foreign travel. Travel associated illness has also been identified as a significant factor in three most frequently reported gastro-intestinal diseases in Ontario, namely campylobacter enteritis, salmonellosis, and giardiasis.[1]

This article describes the characteristics of travel associated illness for 1999 as well as the findings from the increased number of Salmonella enteritidis and Shigella sonnei cases noted in the late winter/early spring of 2000.

Background

An increase in the number of Salmonella enteritidis cases was noted in Ontario in February, 2000. An investigation was conducted and a questionnaire was administered on S. enteritidis cases by local health unit staff. Between March 1 and April 11, 2000, the Central Public Health Laboratory reported 107 cases of S. enteritidis. Of the 107 cases, local health units submitted 41 (38%) completed questionnaires; of these, 36 (88%) were associated with travel outside of Canada and 5 (12%) were not linked with travel. By April 2000, the increase in the number of cases of S. enteritidis and Group D Salmonella cases as well as the association with travel was identified in all provinces except New Brunswick.[2]

In late March 2000, an increase above expected in the number of Shigella sonnei cases in Ontario was identified. A questionnaire was provided to health units to be administered on cases. Between March 24 and April 9, 2000, the Central Public Health Laboratory identified 28 cases. Of these, local health units submitted 13 (46%) completed questionnaires; of these, 10 (77%) were identified with travel and 3 (23%) were not linked with travel.

At the time of both of the investigations described above, no questionnaires were administered by City of Toronto health unit staff due to a labor dispute.

The results of these two investigations prompted a review of Reportable Diseases Information System (RDIS) [3] data to describe the epidemiology of travel associated illness.

Methods

Nine reportable diseases from RDIS were chosen for analysis because of their potential to result in enteric illness. The diseases were amebiasis, campylobacter enteritis, cryptosporidiosis, giardiasis, hepatitis A, paratyphoid fever, salmonellosis, shigellosis, and typhoid fever. The records for these diseases were considered if the "Episode Date" (i.e., the date of onset or its best estimate) was in 1999.

Cases were categorized as 'Travel Associated', 'Other', 'Unknown', or 'Missing' based on the information in any one of the four RDIS variables "Specific Source", "Risk Factor", "Risk Other - Specify", or "Travel Country".

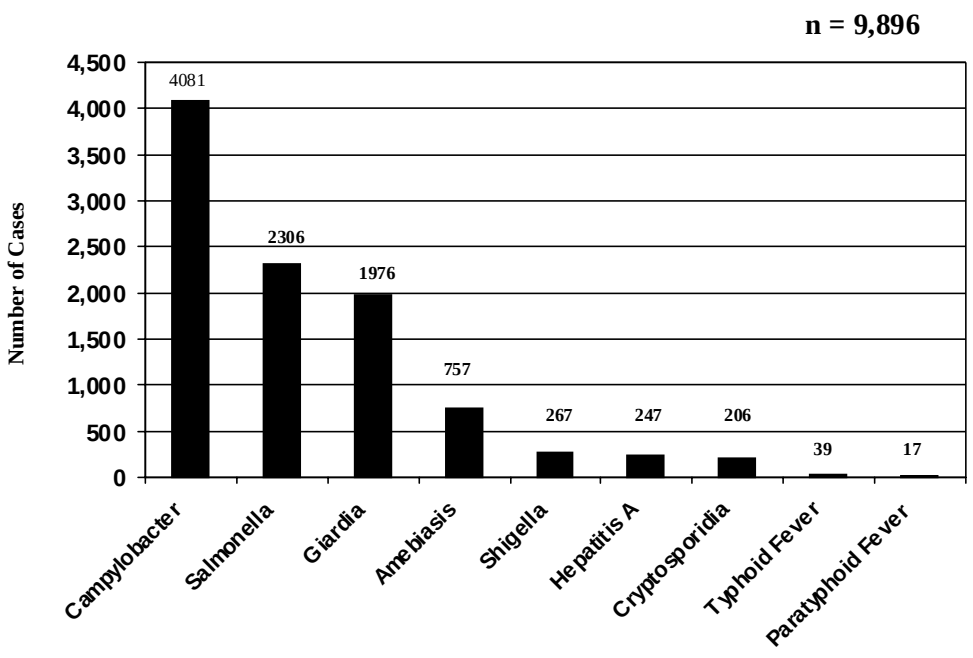
Cases were considered 'Travel Associated' if any one of the four RDIS variables had the travel destination or 'travel' identified. Travel destinations within Canada were not included. Only the first country was considered in the analysis if more than one country was named. If the travel destination was not a geographic location but name of a resort not associated with Canada (e.g., Jack Tar Village), the illness was considered 'Travel Associated'.

Cases were considered 'Immigrants' if any one of the variables had identified the case as such. Cases were considered 'Other' if any one of the variables had identified any cause or source of illness, or any possible or potential cause or source of illness, other than 'Travel'. Cases were considered 'Unknown' if any one of the variables had 'unknown' or 'case is untraceable' listed.

Results

There were a combined total of 9,896 reports of amebiasis, campylobacter enteritis, cryptosporidiosis, giardiasis, hepatitis A, paratyphoid fever, salmonellosis, shigellosis, and typhoid fever in 1999. The number of cases by disease is shown in Figure 1. Of this total, 1,211 (12.2%) were 'Travel Associated', 1,633 (16.5%) were 'Other', 178 (1.8%) were 'Unknown', 23 (0.2%) 'Immigrated', and 6,851 (69.2%) were 'Missing'. Note that for the remainder of the results, the 23 'Immigrated' cases were combined with the 'Other' category such that 'Other' totaled 1,656 (16.7%) cases.

Figure 1. The Number of Cases of Selected Reportable Enteric Diseases in Ontario, 1999.



Of the 1,211 'Travel Associated' cases, the response 'travel' was indicated in 109 cases. The leading travel destination by country associated with illness was India with 140 cases (Figure 2).

The largest number of 'Travel Associated' reports was caused by campylobacter enteritis with 309 cases. For the individual diseases, paratyphoid was most often associated with travel (16/17=94% of cases) (Figure 3).

Of the 1,211 'Travel Associated' cases, 619 (51.1%) were male and 592 (48.9%) were female. The age distribution by number of cases and rate per 100,000 persons is shown in Figure 4. One peak in the number of 'Travel Associated' cases occurred from January to April and another peak occurred from July to September (Figure 5).

Discussion

Misclassification of 'Travel Associated' cases may have occurred if the case did not acquire the illness while outside of Canada. However, misclassification may also have occurred in the other direction as it is likely that there were a number of 'Travel Associated' cases that were not classified as such in the 6,851 cases with 'Missing' data. Thus the 12.2% of cases classified as 'Travel Associated' would be higher.

The largest number of 'Travel Associated' cases was caused by campylobacter (309) and salmonella (210), however, because of the large number of these cases reported, the percent of 'Travel Associated' illnesses for these two diseases were among the lowest of the nine diseases, at 7.6 and 9.1 percent, respectively. Amebiasis, shigellosis, and hepatitis A ranked fourth to sixth in frequency of the nine diseases with 757, 267, and 247 'Travel Associated' cases, respectively. More than one-quarter (23.4, 29.6, and 33.2 percent, respectively) of these three diseases were 'Travel Associated'. By contrast, 94.1 and 92.3 percent of paratyphoid and typhoid cases were 'Travel Associated', however, the number of cases was only 17 and 39, respectively.

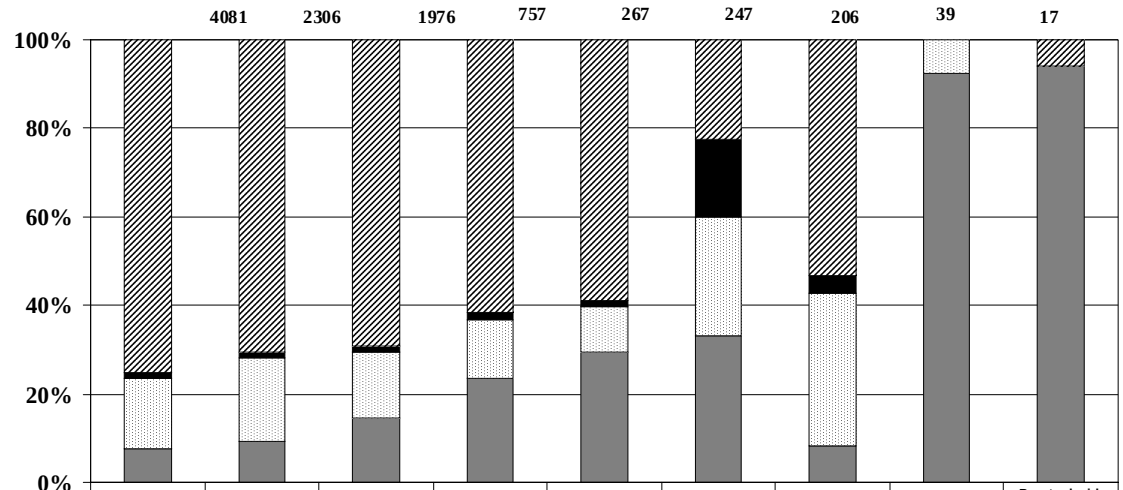
Except for the 10-19 year age group, the younger age groups had the highest rates of 'Travel Associated' disease and the rates declined steadily as the ages increased. Sixty-nine percent of the 'Travel Associated' cases were less than 40 years of age whereas 40% of the Ontario population (1999 population estimates) was less than 40 years of age.

The two moderate peaks in 'Travel Associated' illnesses from January to April and July to September are

Figure 2. Travel Destination, By Country, 1999.	Number	Total
Travel	109	**109**
Asia	9	**424**
India	140	
Pakistan	107	
China	24	
Bangladesh	21	
Philippines	19	
Israel	12	
Thailand	10	
Indonesia	9	
Russia, Vietnam	8	
Sri Lanka	7	
Nepal, Syria, Turkey	6	
Jordan, Saudi Arabia	5	
Iraq	4	
Japan, Lebanon	3	
Afghanistan, Armenia, Korea	2	
Burma, Cambodia, Iran, Kuwait, Singapore, Taiwan	1	
Caribbean	5	**176**
Cuba	68	
Dominican Republic	60	
Jamaica	15	
Trinidad & Tobago	5	
Barbados, St. Vincent & The Grenadines	4	
Bahamas, Haiti, St, Martin	3	
St. Kitts & Nevis	2	
Antigua, Belize, Bermuda, Puerto Rico	1	
North America		**166**
Mexico	114	
U.S.A.	52	
Europe	9	**114**
Portugal	22	
United Kingdom	17	
France, Spain	11	
Yugoslavia	8	
Germany, Greece, Italy, Ukraine	5	
Bulgaria, Mediterannean, Poland	3	
Albania	2	
Belgium, Czech Republic, Hungary, Netherlands, Romania	1	
Africa	29	**87**
Morocco	14	
Egypt	12	
Ghana	6	
Kenya	5	
Ethiopia, Somalia, Sudan	3	
Nigeria, Togo	2	
Algeria, Botswana, Ivory Coast, Mali, South Africa, Tanzania, Tunisia, Zambia	1	
South America	8	**75**
Ecuador	23	
Peru	12	
Venezuela	9	
Brazil, Guyana	6	
Columbia	4	
Bolivia	3	
Argentina, Chile	2	
Central America	6	**53**
El Salvador	21	
Guatemala	9	
Costa Rica	7	
Honduras	6	
Nicaragua	4	
Australia and Oceana		**7**
Australia	4	
Fiji, New Zealand, Polynesia	1	
Grand Total		**1211**

Figure 3. Selected Reportable Enteric Diseases, by Travel Association, 1999.

n = 9,896



	Campylobacter	Salmonella	Giardia	Amebiasis	Shigella	Hepatitis A	Cryptosporidia	Typhoid Fever	Paratyphoid Fever
Missing	3065	1628	1367	467	157	56	110	0	1
Unknown	54	30	26	13	4	43	8	0	0
Other	653	438	298	100	27	66	71	3	0
Travel	309	210	285	177	79	82	17	36	16

Figure 4. Age Distribution of Travel Associated Selected Enteric Disease Cases by Number and Rate per 100,000 Persons, 1999.

n = 1,211

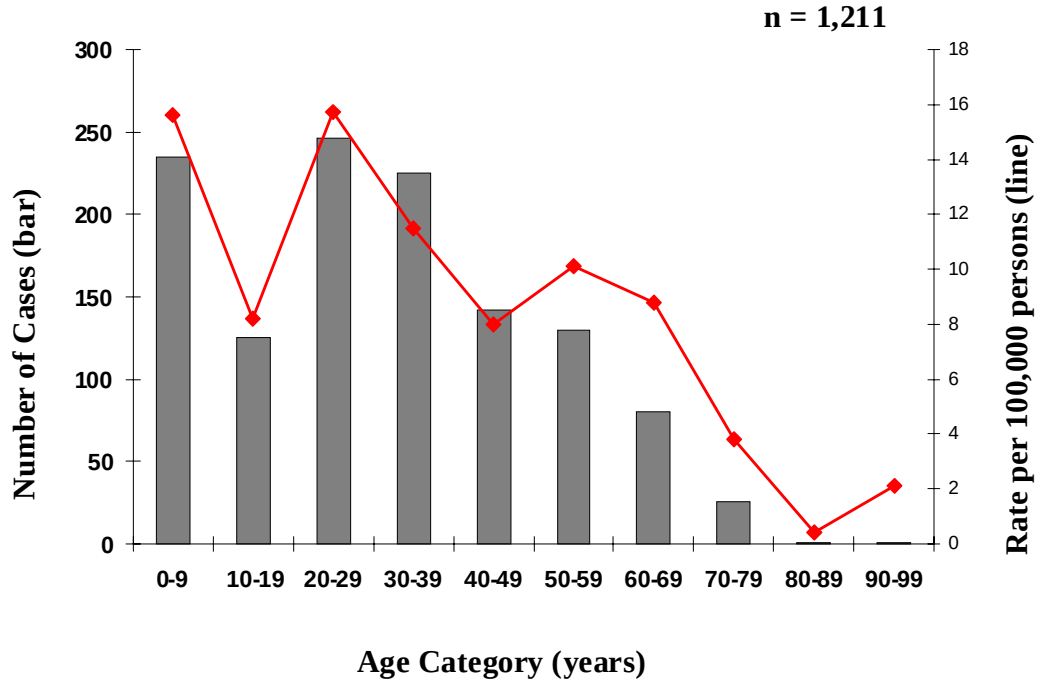
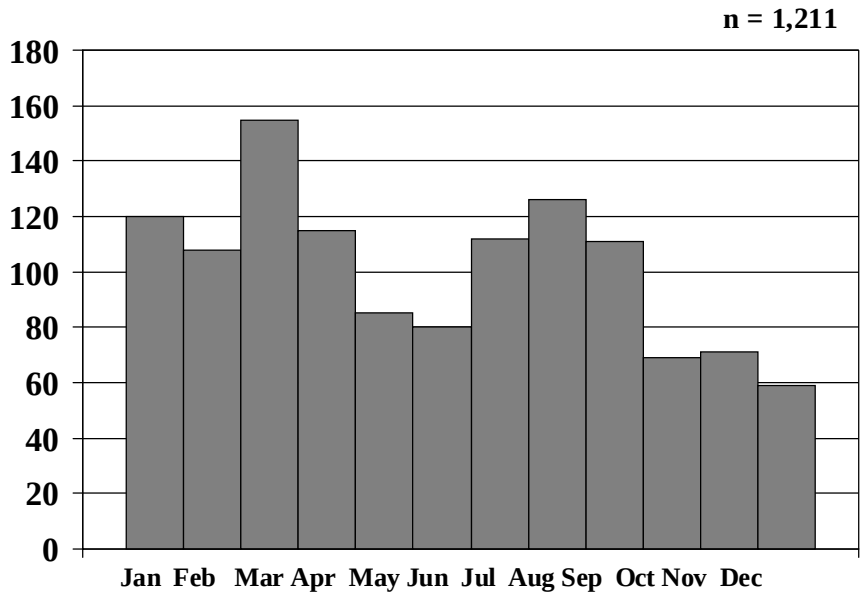


Figure 5. Travel Associated Selected Enteric Disease Cases by Episode Date, 1999.



consistent with periods of time when people like to take vacations, i.e., in mid-winter and summer. A separate analysis of the temporal distribution of Caribbean associated cases showed a marked peak from January to March.

Conclusion

Travel associated illness is defined in this article as illness acquired while travelling outside of Canada. Travel associated illness contributes significantly to the burden of reportable enteric diseases in Ontario. It is likely that the results shown under-represent the true number of travel associated cases. From the public health perspective in Ontario, most travelers recognize the importance of safe food and water; however, certain precautions may be inadvertently overlooked while traveling, and travelers may assume that foods and beverages served in selected settings are safe. The burden of illness resulting from transmission of these illnesses from returning individuals to other persons is difficult to determine.

At least 12% of the burden of selected reportable enteric diseases in Ontario is attributable to travel. The percent of travel associated cases for certain diseases such as typhoid and paratyphoid was very high, however, the total burden of illness from these cases was relatively small. There was a relatively small percent of travel associated illness for diseases such as campylobacter and salmonella, however, the total number of cases was relatively large.

There is a large diversity of countries as travel destinations. Moderate peaks in travel associated cases occurred from January to April and from July to September. The proportion of travel associated cases under 40 years of age was greater than the proportion of the population under 40. The interview of every case of reportable enteric disease should include inquiry about travel.

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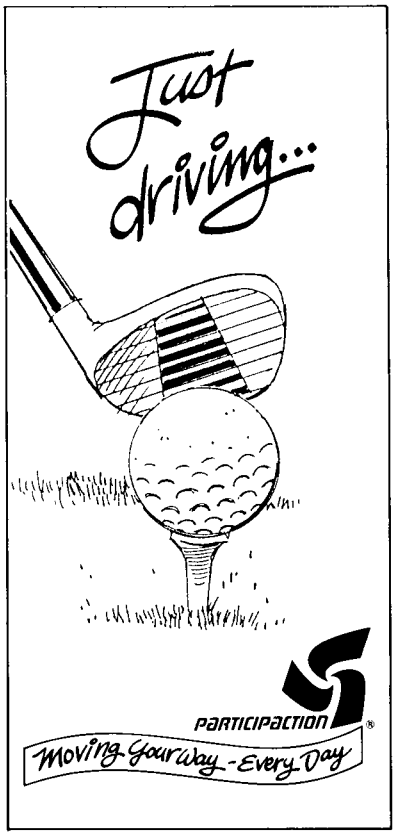

Promoting the Healthy Babies Healthy Children Program Amongst Physicians and Midwives in Hamilton - A Collaborative, Multifaceted Strategy

Introduction

Effective interventions to reduce low birth weight and child abuse/neglect have utilized prenatal or early infancy, multi-strategy, and community-based approaches.[1,2] Postnatal home-visiting support programs have shown some modest benefits for socially disadvantaged mothers and their children, including reduced rates of child injury and maltreatment.[3,4] A recent review of home visiting programs, emphasized the importance of a multi-strategy approach for families in need.[5] Emerging literature suggests that the accurate prediction of at-risk families requires more than a single screening procedure using standardized tools and/or direct observation of parenting skills.[6] Healthy Babies, Healthy Children (HBHC) is a provincial program designed to identify and assist at-risk families using such a framework.[i] During the early planning phase of the HBHC Program in Hamilton-Wentworth, it was recognized that we needed to actively promote HBHC so that it would be perceived as useful in assisting practitioners with the identification and support of vulnerable pregnant women and families. Previous reports have documented the importance of public health working in partnership with primary care providers to achieve public health goals.[7] There is ample research evidence that identifies significant barriers to implementing changes in physician practices, including: variation in practice structures; supports available to physicians, time pressures, lack of

[i] The Healthy Babies, Healthy Children (HBHC) Program is a prevention/early intervention program (for pregnant women and families with children 0-6 years of age) that began January 1, 1998 in the province of Ontario. The initial components of the HBHC Program focused on: postpartum screening and referral by hospitals, community referrals for prenatal clients and children 0-6 years, phone and in-home assessments by public health nurses, referral to appropriate community agencies, and service co-ordination. Additional in-home support by Family Home Visitors is a key component to the services provided to families. Family Home Visitors provide peer support, practical parenting tips and help bridge the barriers that prevent families from accessing community supports.

awareness of community-based issues, remuneration; etc.[8,9,10]. A recent systematic overview identified that reminders, patient-based interventions, outreach visits (academic detailing), and the use of opinion leaders are effective strategies in changing physician performance. Multifaceted approaches are particularly effective.[11,12,13]

The ultimate goal of this project was to encourage physicians and midwives to identify and then refer at-risk families and pregnant women to the HBHC Program. A multifaceted approach including academic detailing was used. To assist with the development of an optimal strategy this study was designed to determine community practitioners perceptions of: 1) psychosocial risks in their practices and the adequacy of community referral sources; and 2) possible enhancers and barriers to implementation of the Healthy Babies, Healthy Children (HBHC) Program.

Methods

The Hamilton-Wentworth Social and Public Health Services Division (SPHSD) and the Department of Family Medicine, McMaster University developed a formal partnership to disseminate information about the HBHC program to community family physicians, obstetricians and midwives. A primary care physician who had expertise in obstetrics was identified as an opinion leader and agreed to work with other physicians and midwives through academic detailing, presentations at academic rounds, mail-outs, and educational materials. The academic detailing approach used principles outlined in Table 1 by Sumerai and Avorn (1990).[14] The SPHSD provided remuneration for the direct physician time involved in the project.

The opinion leader developed an open-ended questionnaire that was designed to assess the following aspects of the Healthy Babies Healthy Children (HBHC) Program:

1. The physicians'/midwives' level of knowledge of the program prior to the interview;
2. Any concerns that they or their patients might have related to the program;
3. The type of feedback that they would find useful concerning their patients involvement in the program; and
4. The likelihood, based on the interview information, that they would make prenatal or postnatal referrals to the program.

A quantitative survey was also completed which asked each physician/midwife, on a scale of 1-7, how often they screened and used community resources for pregnant women with the following issues: emotional difficulties or illness, substance abuse, family violence, financial difficulty, social isolation or lack of social support, and cultural or language isolation. Participants were asked their opinions with regard to the current adequacy of community resources in each of the categories. Demographic information about the individual practices was also collected.

Table 1: Principles of Academic Detailing: [1]

1. Conduct interviews to establish baseline knowledge
1. Focus programs on specific categories of physicians as well as their opinion leaders
2. Define clear educational and behavioural objectives
3. Establish credibility through a respected organizational identity
4. Stimulate active physician participation in educational interactions
5. Use concise educational materials
6. Highlight and repeat educational messages
7. Provide positive reinforcement in follow-up visits/contacts

[1] Adapted from Sumerai SB and Avorn J (1990) [x]

Prior to starting the interviews, the opinion leader made presentations at the Department of Family Medicine and Department of Obstetrics and Gynecology meetings at both local hospitals. A flyer describing HBHC was sent to all family physician, pediatrician, obstetrician and midwifery offices. A list of offices to receive academic detailing was compiled using feedback from public health nurses to identify practices that might have a higher proportion of "at-risk" families, or a high volume of obstetrical patients. A list of offices to receive academic detailing was compiled using feedback from public health nurses to identify a variety of different practice styles and population groups, including practices that might have a higher proportion of "at-risk" families, or a high volume of obstetrical patients.

The interviews began in August of 1998 and were completed in September of 1999. The 30-minute interview consisted of a general discussion around the broad goals of the HBHC Program, emphasizing such aspects as ease of access to the "system" for patients and physicians, the comprehensive and coordinated approach to services, and the provision of feedback to the physician/ midwife involved in the care of the family. A handout was provided with more specific details on the screening process, service network, home visiting support, and a description of how the patient would move through the system. Although the prenatal screening piece of the program was emphasized, practitioners were also given information about referrals for children up to age six. Contact numbers were boldly indicated on all printed material. There was also a handout for patients that could be given prenatally.

Data Analysis

All data were directly entered from the instruments into SPSS 10.0 for Windows data entry system. Descriptive statistics were used to portray the characteristics of participants and their practices. Frequency counts and percentages, means and standard deviations were calculated as appropriate.

Results

Of 75 offices contacted for an interview, 19 refused, generally stating a lack of interest in the project, or lack of time, and 56 accepted the invitation, which yielded a response rate of 75%. A few of the offices had more than one practitioner, with the interview completed by 61 individuals. The median year of graduation was 1981 (range 1944 to1997). Sixty-two percent of the providers (n= 38/61) were fee-for-service and the remaining 38% (n= 23) were HSO (Health Service Organization) funding. The majority of respondents (n=50/61, 82%) had >1000 patients with the median number being 1775. Family physician (n=52), midwife (n=3) and obstetrician (n=6) practices saw an average of 15 (range 2-50), 60 (range 50-70) and 94 (range 16-240) prenatal patients per month respectively.

Table 2 indicates respondent's estimates of the percentage of their prenatal patients presenting with one of six risk factors. There was a wide variation in perceived risk factors amongst the practices with financial difficulty being the most common (30%) followed by social isolation (20%) and emotional illness/ distress (16%). Cultural/language isolation, family

Table 2: Respondent's estimates of risk factors present in their prenatal population (% of total prenatal patients):

RISK FACTOR	MEAN (%)	MEDIAN (%)	RANGE	S.D.
Financial difficulty	30	20	5-90	24.1
Social isolation	20	10	0-90	24.1
Emotional illness or distress	16	10	0-80	15.1
Family violence	12	5	0-80	15.4
Cultural or language isolation	11	5	0-80	16.1
Substance abuse	10	5	0-80	13.1

violence, and substance abuse were the least prevalent (12%, 11% and 10% respectively). Table 3 indicates the percentage of respondents who scored ≥ five on a 7 point scale (7 being the most positive response) in response to three questions concerning the risk factors previously listed. Practitioners most often asked their patients about emotional illness or distress (79%) and least often explored financial difficulty or language/ cultural isolation (45%-50%). There was a similar pattern in low routine referrals for financial difficulty or language/cultural isolation (21%-35%). All issues with the exception of substance abuse were perceived as poorly resourced (15% - 39%), with language/cultural isolation ranking the lowest. The practice survey portion of the interview averaged 15% missing data per item. Cultural or language isolation was the most frequent non-response item.

Analysis of the interview data specifically relating to the HBHC Program revealed a number of themes. Sixty four percent of practitioners (n=39/61) knew little or nothing about the program at the time of the interview. A small number (n=11/61, 18%) knew that the program was designed to screen and connect high-risk families to sources of support. Only three respondents (5%) knew about the promotional fridge magnets given to all postpartum women at hospital discharge and the posters available for physician/midwives offices. Of the 22 respondents (36%) that had knowledge of the program, 50% (n=11/22) had received the information at department rounds. A smaller number remembered the mail outs (n=4/22, 18%) or had learned about the program one-on-one from knowledgeable individuals, i.e. nurses, colleagues (n=7/22, 32%).

Thirty-eight percent of participants (n=24/61) did not see any significant barriers to their referring patients to the program. There were a group of practitioners (n=6/ 27, 22%) who felt that they already had excellent resources or were concerned about duplication of existing resources. Professional barriers such as time for screening in the office was an issue for 18.5% of the respondents (n=5/61). One respondent expressed concern that there may not be enough resources to meet the demands of referrals to the HBHC Program.

Of the providers who did raise issues (n=27/61, 44%), 30% (n=8/27) identified that communication was essential. There was consistency in the recommendations for feedback. All of the physician/midwives (n= 61/61, 100%) wanted a short form that indicated whether contact was made, the problems/risks identified, the services recommended, the follow up plans and the name of a contact person. Some practitioners (n=10/61, 16%) indicated they would like contact by telephone with any urgent concerns or if the client was discharged from HBHC (n=7/61,11%). A small percentage (n= 15/57, 26%) did not perceive any significant barriers to patient participation. However, the potential for the program to be seen as "judgmental," "someone spying on [family]," "fear of CAS," and "invading their privacy," were recurrent themes that emerged during the interviews (n=22/57, 39%). Three providers (5%) felt

Table 3: Respondents Opinions regarding frequency of history taking, referral and adequacy of resources related to prenatal risk factors (n=61)

enatal Risk Factor	Routinely asks (%)	Routinely refers [1] (%)	Adequate Resources (%)
otional illness or distress	79	58	39
cial Isolation	70	56	33
bstance abuse	69	61	57
mily violence	62	59	36
nancial difficulty	50	35	28
nguage or cultural isolation	45	21	15

[1] A small number of offices have social work attachments or other ”in house” resources that may reflect in the referral rates to outside community resources

there would be language or cultural barriers for their patients. One physician (2%) felt that long waiting times for services or assessment would result in lost faith in the program for both providers and patients. Despite these concerns, most of the clinicians (n= 56/61, 92%) stated that they would refer patients to the HBHC Program and that patients would accept the service if it were "sold " properly (i.e. in a non-judgmental and positive manner.

Discussion

Recent national guidelines in both Canada and the United States recommend that the identification of psychosocial issues should be a priority in prenatal care.[15,16] Chronic stressors such as lack of money for basic and poor social support are associated with postpartum depression.[17] Lack of social support, recent life stressors, psychiatric disturbance in the mother, and an unwanted pregnancy are predictors of child abuse.[18] A British study suggests that social deprivation is strongly correlated with low birthweight.[19] Respondents in this study identified financial difficulty and social isolation as the most frequent issues they encounter in their practices. This is consistent with demographic data indicating that Hamilton-Wentworth has the highest prevalence of socioeconomic risk factors in Central West Ontario.[20] Despite the local demographics and the recommendations in the literature, about one-third of the practitioners did not routinely screen for these concerns in their prenatal patients. A higher proportion would not routinely refer to community services to address these issues.

The low perceived prevalence of cultural/language isolation is surprising in that Hamilton-Wentworth is a culturally diverse region with 28% of its citizens speaking languages other than French or English.[21] It is possible that practitioners whose patients have a high incidence of sociodemographic risk factors did not agree to participate in this study. Health care providers identified that language/cultural diversity and financial difficulty were the issues they had the least resources to address. Research evidence suggests that postpartum women from non-English-speaking backgrounds are frequently alone, without practical household help, and lack support or guidance.[22] The HBHC Program can specifically address these issues through the availability of in-home support by multicultural Family Home Visitors. The rate of screening for family violence is also low, given that the incidence of violence in pregnancy is between 4 and 17 percent.[23] Abuse in pregnancy is associated with unintended pregnancies and other risk factors that may impact negatively on reproductive health status, emphasizing the importance of exploring the issue of violence with all pregnant women.[24]

Few respondents recalled receiving promotional materials through mail-outs and presentation of HBHC at department rounds, suggesting these are not effective strategies by themselves, to increase clinicians' knowledge of the program. This finding is similar to previous research indicating that the provision of written materials without other interventions to reinforce its impact, is not effective in changing behavior.[25] Many of the potential barriers identified by the respondents in this study are concerns shared by other community agencies that provide service to this population, emphasizing the need for a well-functioning system of services.[26] Our interview data would suggest that referrals to a community-based program such as HBHC are more likely to occur if it is promoted in a non-stigmatizing manner, with the clinician receiving appropriate feedback. These suggestions, and requests to simplify the referral process have resulted in the development of a simple referral form and a standard letter that is faxed (with client consent) to physicians/midwives after the initial postpartum visit or upon completion of the in-home assessment. The shift to universal postpartum contact by a public health nurse (PHN) should also help to "normalize" participation in the program.

This study is limited by the fact that practitioners may have responded as they felt they should have, as opposed to how they actually practice. Though we approached a broad range of individuals, this was not done in a random fashion and some physicians/midwives who may provide care to different socioeconomic groups may have declined the interview. This would tend to skew the assessment of risk factors in our population. There was also no follow-up data to assess the impact of the academic detailing on providers' knowledge and behavior. Clinicians may not ask about risk factors because they are either unaware of, or do not believe that resources exist to deal with them. In this study, the factors with the lowest perceived resources were the least frequently screened for. It appears that perceived lack of resources acts as a deterrent to referring patients

to community services. Discussions with practitioners need to emphasize the importance of antenatal psychosocial assessment, the literature to support the benefits of early intervention, and the availability of specific services for their patient population.

Conclusion

Although the sample is small, this project has provided important information that has been useful in planning specific promotional strategies for working with physicians and midwives. This multifaceted approach, in particular the academic detailing component, although labour intensive, appears to be valuable as a vehicle for increasing physicians and midwives' understanding of the program based on the immediate feedback that we received. The suggestions that were made for specific strategies have subsequently been implemented in our local program. This approach may be useful to consider in other communities where collaboration between traditional medical care systems and community care is necessary to implement prenatal/early childhood support programs. The partnership developed between the Hamilton-Wentworth Social and Public Health Services Division and the Department of Family Medicine through this project, has provided opportunities for further collaborative projects.

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Communiqué

Public Health Research, Education and Development Program

Sudbury & District Health Unit / Service de santé publique

COMMUNITY-BASED PRE-SCHOOL NUTRITION SCREENING: FEASIBILITY ASSESSMENT

Introduction and Rationale

Nutrition is a vital component for the support of optimal growth and development in childhood. Investment in the early years is critical and the food choices families make for their children play a direct role in the nutritional status, eating behaviours, health and school readiness of young children. Nutrition significantly influences a child's health status; young children with nutritional problems have been shown to be at risk for growth, behavioural and developmental problems.[1] Parents need to have a simple way to tell if their child is well-nourished and is a healthy eater or if their child needs professional dietetic services. The use of screening tools to facilitate early identification and intervention is crucial in community health care to ensure the best use of limited health professional services. However no valid and reliable community-based nutrition screening tool for pre-school children (aged 3-5 years) currently exists.

This study consisted of two major components: the development of a nutritional screening tool for pre-schoolers and the pre-testing of this tool in a developmental sample to determine the feasibility of conducting a large-scale validation of the tool in a community setting. This study compares the use of a questionnaire instrument against the current standard, a dietitian assessment. This paper summarizes the work undertaken to develop and pre-test the tool, outlines the results and provides suggestions for undertaking a large scale validation study of the tool.

Tool Development

Factor Identification

Items regarding nutrition issues within the pre-school population were included based on a literature review and professional dietetic input. A literature review of all English pediatric, nutrition screening-instruments yielded three previously developed tools of significance: two pediatric screens developed in British Columbia [2, 3] and the American PEACH survey, Parent Eating and Nutrition Assessment for Children with Special Health Needs.[4] These tools were reviewed and items, which pertained to the target group, were considered. Behaviours and factors that led dietitians and other health professionals to consider a pre-school child to be at nutritional risk and which might predict the risk for impaired nutritional status were also considered. The final tool included the following seven attributes: food; eating habits, food security; body image; activity level; overall health; and pediatric body mass index (BMI).

Questionnaire Development and Content Validation

The "**STEP 2000**" (**S**creening **T**ool about **E**ating for **P**re-schoolers), a questionnaire instrument, was developed with the intention that a child's parent or guardian would be able to complete the survey at an established community-based pre-school screening program in approximately five minutes. The tool included 29 questions, covering the seven attributes described above. Two of the questions, height and weight, required the parents/guardians to use the calibrated instruments provided onsite and record the measurements on the survey tool.

Each question was considered as to its relevance to the concept being measured. In addition, the overall questionnaire was considered to ensure that all aspects that impact on a pre-schooler's nutritional status were adequately covered. A nutritional epidemiologist specializing in pediatrics, reviewed the screen for content validity and for survey format. An expert group of ten pediatric and nutrition professionals were asked to determine the content and face validity of the items and the questionnaire was modified accordingly.

The STEP 2000 screening tool was adapted to include parents or care-givers with low-literacy skills. The Flesch-Kincaid Grade Level Score, a standard literacy measure available in Microsoft Word, was used to ensure that the survey and consent form was written at or below a grade six reading level. Pre-testing was conducted with five parents to ensure that the target population understood the items.

After careful consideration and a review of the literature [5], it was decided that the accuracy of responses for most items would improve if the allowable range of responses was more than dichotomous (i.e., yes/no). A five-point response scale was used in the final version of the STEP questionnaire.

Developing the Scoring System

The ten nutrition professionals that were originally consulted with regards to the tool's face validity were again asked to assist in the determination of weights for each item. This expert consultation allowed for certain items, that might have a stronger impact on nutritional risk, to be weighted more heavily and therefore have a greater contribution to the final score. The mean values of these ten professionals' weighting scores were used to calculate the total derived screen score. All items were recoded so that a higher score was indicative of a higher nutritional risk. Total possible screen scores ranged from a minimum of 87 to a maximum of 435 points. Through discussions with pediatric and nutrition experts, three unique levels of nutritional risk for preschoolers were recognized: "no nutritional concerns"; "some nutritional concerns"; and "requires referral".

Data Collection of Developmental Sample

The pre-test was undertaken to assess the feasibility of validating the STEP tool. The STEP tool score was compared to the current standard measure of nutritional risk, the registered dietitian's assessment of the child after consultation with the parent and child.

Data Collection With Screening Tool

The overall study design, survey content and parental consent letter were approved by the Sudbury & District Health Unit's Ethics Review Committee. The tool was piloted within a well-established, multidisciplinary, pre-school-health-and-school-readiness screening event in the Regional Municipality of Sudbury, Ontario. This was the third year that a nutrition component and dietitian involvement had occurred in this project in conjunction with other screening programs such as speech and language, developmental, vision, hearing and dental. The sample was drawn from a total of 103

male and female pre-school children between the ages of 2 and 6 who attended the community-based pre-school screening event with their parent or guardian. Participation at each of the screening areas was voluntary and parents were able to opt out or to discontinue any screening process at any time.

The trained volunteer who staffed the nutrition screening area was not from the same community to minimize possible bias. Parents were informed that they could choose not to participate in the validation project without affecting service received from Sudbury & District Health Unit. To approximate field conditions and avoid influencing responses, consenting parents completed the STEP prior to the nutritional assessment.

Data Collection Using the Dietitian's Assessment

Only those parents who agreed to book an assessment for their pre-schooler with a dietitian completed the screening tools. Appointments were completed within one month of the screening date at a location and time convenient to the child's parent. Two registered dietitians were involved in conducting the assessments and they were blinded to the participants' STEP scores.

Dietitians received training from the project dietitian to ensure that assessments were completed in a consistent manner to increase inter-rater agreement. Similarly, the dietitians used a standardized assessment worksheet for the nutritional assessments of the children, again to contribute to inter-rater agreement. The dietitians conducted a nutritional assessment including a review of a three-day food intake record, the child's height and weight measurements and a review of the child's diet. The dietitians completed a global nutritional risk ranking for each participant using the three established levels:

Level 1:	No nutritional problems/concerns
Level 2:	Some nutritional problems/concerns (received an information package and advice)
Level 3:	Requires referral (received advice and information for appropriate follow-up)

Data Entry

All data obtained during the project were coded and no names were attached to the data other than for the purposes of booking the dietitian appointments. Data were entered by the project analyst using the statistical software SPSS version 9.0.

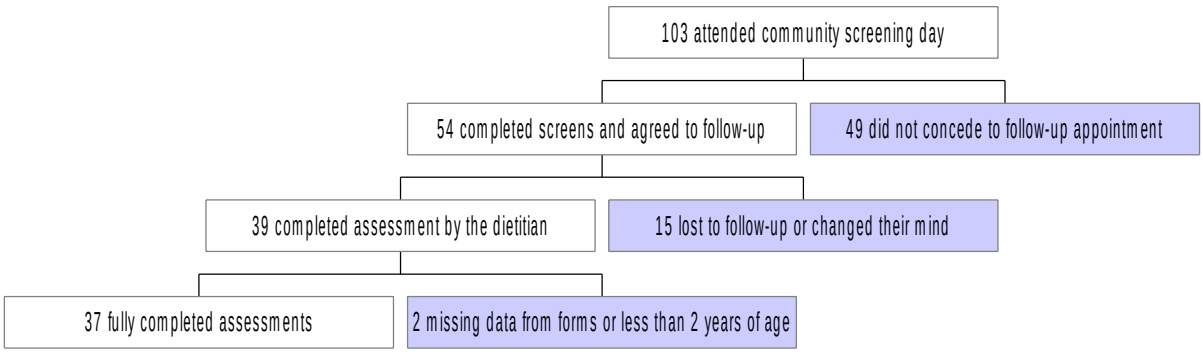
Pre-Test Results

Sample Characteristics

Figure 1 outlines the inclusion criteria for the children who participated in the community screening day.

Of the 54 completed screens, mothers completed the majority of the screens (89%). Fifty-one of the children's parents answered the optional demographic questions, however, only 42 answered the income question. Of the 54 children with completed screens, 28 (52%) were male and 26 (48%) were female. Similarly, of the 37 contained in the final sample 20 (54%) were males and 17 (46%) were females. Eighty-nine percent of the screened pre-schoolers were either three or four years of age at the time of the screen. Compared to Statistics Canada Census information for the Regional Municipality of Sudbury, a greater proportion of this sample was Anglophone, educated, and with higher incomes than might be expected.

Figure 1: Inclusion Criteria Diagram



Item Response and Frequency Endorsement

The frequency with which each item on the screen was answered by the parents or guardians was examined, in order to identify any variation. Items from the screen that most respondents answered in the same way (e.g. frequency endorsement) may be considered for discard, as they are not contributing to useful differentiation of the respondents within the screen.

Questions that showed little variation on a scale included: *child takes part in active play daily; child has a milk allergy; child is on a special diet; and parent had concerns about having enough to eat because of cost.*

One dichotomous question "whether the child has seen a registered dietitian" also had little variation with all but two respondents answering "no". Only one item had no variation (answered the same by all participants): *not having enough to eat because of cost*.

Inter-Correlated Items on the Screen

Several questions were found to correlate strongly with each another and therefore it may be possible to eliminate certain questions. "How the respondent feels about their child's health" correlates with "how the respondent feels about their child's eating habits", and all the food security questions correlated with one another. The milk allergy and special diet questions also correlated with the food security questions. Finally, "respondent has battles with their child over eating" was correlated with "respondent feels they need to tell their child to eat more".

Pediatric BMI

Body Mass Index (BMI) has recently been adapted for use in the American population of 2-18 years of age 6. The calculation of BMI is identical for both children and adults, but the categories for designating risk are different. The Canadian adult "at risk" categories are BMIs less than 20 or greater than 27, while the child categories are based on percentiles by the American National Center for Chronic Disease Prevention and Health Promotion (NCCDPHP). If a child or adolescent's BMI falls between the 5th and 85th percentiles for their age and sex then they are ranked within the normal range. Similarly, a BMI between the 85th and 95th percentiles indicates a risk of becoming overweight and a BMI of less than the 5th or greater than the 95th percentiles indicates concern of being underweight or overweight respectively.

This indicator was included in the nutritional screening tool with the belief that it may be an indicator of risk. In order to obtain BMI, the parent/guardian measured their child's height and weight. This turned out to be more difficult than was predicted and resulted in incomplete data and the loss of several participants. Also unexpectedly, problems with weight occurred in the dietitian's assessments due to a failure in the equipment.

Clustering

Overall, three out of 37 (8%) of the pre-school children assessed had significant nutrition issues requiring follow-up. An additional 17 (46%) had some nutritional concerns and were provided with written information and verbal professional advice.

Figures 2 and 3 provide scatter diagrams showing the relationship between the dietitian assessment and the total screen score. Due to the problems in obtaining BMI, the screen score was calculated both with the BMI and without, to see if results might differ. The scatter diagrams suggest that relatively distinct groupings or clustering of the screen scores correspond to the three levels of the dietitians' assessments. Thus, the screen scores appear to relate to the assessment levels and provide the screen scores with some ability to differentiate between the groups.

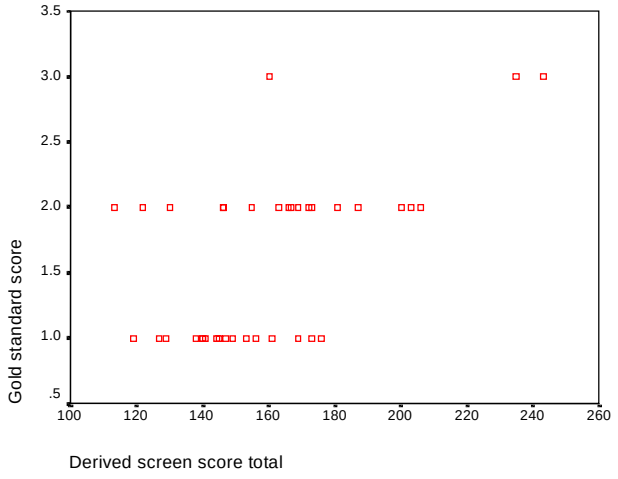
Sensitivity and Specificity

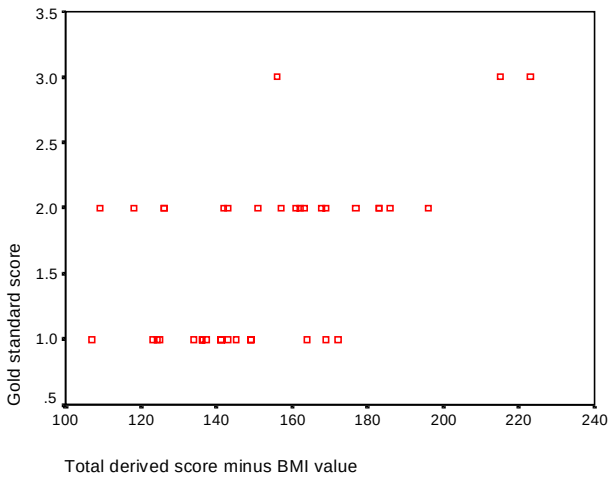
Sensitivity and specificity of the tool were assessed. Receiver operating characteristics (ROC) curves were derived for the evaluation of the sensitivity and specificity of different cut-points. The accuracy of the complete measurement, or of each question may also be useful. ROC curves allow for examination of each possible cutoff level's sensitivity and specificity. A score of 180 on the STEP screen was estimated from the scatter plots to be a possible cut-point for "screening" nutritional risk; this score corresponded with sensitivity of approximately 67%, specificity of approximately 87%, positive predictive value of 29%, negative predictive value of 88%, likelihood of a false negative 33%, and likelihood of a false positive 15%.

Next Steps and Conclusion

Having developed a prototype nutritional screening tool for pre-schoolers and pre-testing this tool in a developmental sample, it is recommended that a large-scale validation of the screening tool be conducted.

Figures 2 & 3:
Gold standard assessment category as compared to the total derived score from the screening tool & Gold standard assessment category as compared to the total derived score from the screening tool minus the BMI value





This project could be carried out over three years in three phases. In the first year, the first phase will involve representative parent focus group testing and nutrition expert review to further modify and refine the draft STEP tool to ensure appropriate wording, format, length, and key concept content. Tool modification and refinement requires consideration of the four issues listed below as the project moves from phase I into phase II (pilot validation and developmental analyses) and finally to phase III (validation and test-retest reliability of STEP).

Shorten Length of STEP Tool

Currently, this screen is composed of 29 items. By comparison, a similar tool, the SCREEN 7 designed to identify nutritional risk in the elderly population, has recently been modified from 15 questions down to 8. Other modifications that may be considered on the STEP screen include the removal of certain questions that are highly correlated to one another. Also, in cases where an item was answered with very little variation it should be removed from the screen as they are not useful in separating the sample participants. The BMI appears not to be useful in this screen and it is troublesome to obtain. Therefore, if the BMI is found to exert little or no effect on the final classification of risk then it may also be removed from the screen.

Increase Sample Size and Ensure Representativeness

Approximately 8% of the developmental sample were identified as having nutritional issues using the dietitian's assessment. Due to the small sample size this meant that sensitivity and specificity were based on the scores of only three children with identified issues. Thus every effort will be made to increase the sample size and ensure that all relevant risk populations are incorporated into the samples.

Minimize Inter-Observer Error

Effort will be made to reduce inter-observer error and standardize the dietitian's assessment. One method of reducing inter-observer error is to perform all the assessments used for comparison to the screen by the same dietitian to yield consistent results. Another technique includes the creation of standardized risk rating tools and then the assessment of these tools by having two dietitians assess a sub-sample of the children to allow for the comparison of the dietitians' assessments. This may lead to a more accurate classification of nutritional risk.[8]

Test Reliability

This project sought to develop a nutritional screening tool for pre-schoolers and to pre-test it within a developmental sample. Although we did not measure

Table 1:
ROC Curve of Derived Screen Score Total and Gold Standard Assessment Category
Coordinates of the Curve
Test Result Variable(s): Derived screen score total
State Variable: Gold Standard Assessment Category

Positive if Greater Than or Equal To	Sensitivity	1 - Specificity
112.00	1.000	1.000
116.00	1.000	.971
120.50	1.000	.941
124.50	1.000	.912
128.00	1.000	.882
129.50	1.000	.853
134.00	1.000	.824
139.00	1.000	.794
140.50	1.000	.735
142.50	1.000	.706
144.50	1.000	.676
145.50	1.000	.647
146.50	1.000	.588
148.00	1.000	.559
151.00	1.000	.529
154.00	1.000	.500
155.50	1.000	.471
158.00	1.000	.441
160.50	.667	.441
162.00	.667	.412
164.50	.667	.382
166.50	.667	.353

Table 2:
ROC Curve of Derived Screen Score Total Minus BMI and Gold Standard Assessment Category
Coordinates of the Curve
Test Result Variable(s): Total derived score minus BMI value
State Variable: Gold Standard Assessment Category

Positive if Greater Than or Equal To	Sensitivity	1 - Specificity
106.00	1.000	1.000
108.00	1.000	.972
113.50	1.000	.944
120.50	1.000	.917
123.50	1.000	.889
124.50	1.000	.861
125.50	1.000	.833
130.00	1.000	.778
135.00	1.000	.750
136.50	1.000	.667
139.00	1.000	.639
141.50	1.000	.583
142.50	1.000	.556
144.00	1.000	.500
147.00	1.000	.472
150.00	1.000	.417
153.50	1.000	.389
156.50	.667	.389
159.00	.667	.361
161.50	.667	.333
162.50	.667	.306
163.50	.667	.278

reliability, in particular test-retest reliability, or the ability of the screen to yield similar scores on two separate occasions, it is an important construct of the screening tool that will be measured in phase III of the project.

Investment in the early years is critical in order that children have the opportunity and resources to reach their full potential. It is clearly recognized that nutritional health status impacts on a pre-school child's growth, development, behaviour, school readiness, and overall readiness to learn. A simple, yet valid and reliable pre-school nutrition screening tool is required. Such a tool will identify "at risk" children sooner so that it will allow for the best use of scarce community dietetic resources.

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❑

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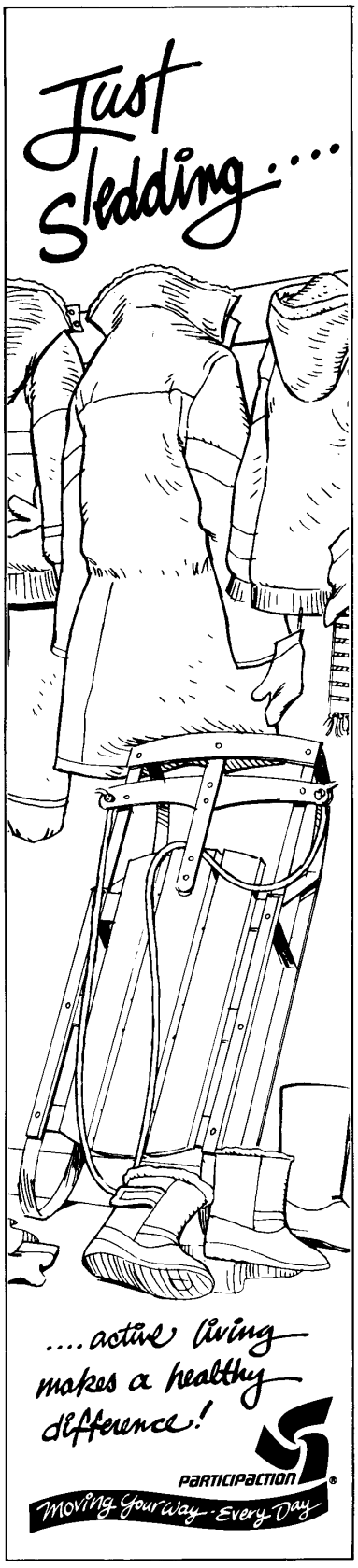

Summary of Reportable Diseases in December, 2000

Health Units by Region	1996 Population	AIDS	Campylo.	Chicken-pox	Chlamydia	Enceph./ Meningitis	GAS	Gonorrhea
Algoma	123,953			32	14		2	
North Bay	93,841			31	6			
Northwestern	80,235				14			
Porcupine	97,437			16	12			
Sudbury	201,154		2		12	1		
Thunder Bay	161,187		1		16		1	
Timiskaming	38,847							
Total - Northern	**796,654**		**3**	**79**	**74**	**1**	**3**	
Eastern Ontario	185,314		4		2		1	1
Hastings-Prince Edward	143,790					1		
Kingston-Frontenac	175,568		1		15	3	1	
Leeds-Grenville	156,129		2	25	4			
Ottawa-Carleton	721,136		16	54	60	3	1	2
Renfrew	97,634		1		1		1	
Total- Eastern	**1,479,571**		**24**	**79**	**82**	**7**	**4**	**3**
Durham Region	458,616		2	223	27	2		3
East York	107,822		1	22	7			3
Etobicoke	328,718		5	15	10	1		1
Haliburton-Kawartha	165,039		1		3			
Muskoka-Parry Sound	78,675			7	1			
North York	589,653		8	55	67			18
Peel Region	852,526		24		42	2	1	6
Peterborough	123,448		2	33	4	1	1	
Scarborough	558,960		8	118	101		1	25
Simcoe County	329,865			70	16	1	1	6
Toronto City	653,734		11	75	26		1	31
York City	146,534		2	1	9			
York Region	592,445		13			2	1	
Total - Central East	**4,986,035**		**77**	**619**	**313**	**9**	**6**	**93**
Bruce, Grey-Owen Sound	153,312		5	15	6			
Elgin-St. Thomas	79,159			24				
Huron	60,220			1	3			1
Chatham-Kent	109,650				5			
Lambton	128,975		1					
Middlesex-London	389,616		4		8	2		1
Oxford	97,142				1		1	
Perth	72,106		4	24				
Windsor-Essex	350,329		10	91	40	1		6
Total - Southwest	**1,440,509**		**24**	**155**	**63**	**3**	**1**	**8**
Brant	114,564				14	2	2	1
Haldimand-Norfolk Region	102,575		2	8	2			1
Halton Region	339,875		6		14	1		1
Hamilton-Wentworth	467,799		7	14	49		2	5
Niagara Region	403,504		9	266	21		2	1
Waterloo Region	405,435		3		24			4
Wellington-Dufferin	217,052		5	14	9	2	1	
Total - Central West	**2,050,804**		**32**	**302**	**133**	**5**	**7**	**13**
December 2000	**10,753,573**		**160**	**1,234**	**665**	**25**	**21**	**117**
*** Total YTD 2000**	**-**	**57**	**4,715**	**23,466**	**13,286**	**367**	**381**	**2,411**
*** Total YTD 1999**	**-**	**125**	**4,077**	**15,657**	**13,296**	**438**	**295**	**2,242**

* Adjusted for deletions and late reports.

Summary of Reportable Diseases in December, 2000

Health Units by Region	1996 Population	PPNG	Hepatitis A	Hepatitis B	Hepatitis C	Hib	Influenza	Measles	Meningo-coccal
Algoma	123,953				7				
North Bay	93,841			1	1				
Northwestern	80,235				1		1		
Porcupine	97,437								
Sudbury	201,154			1	6	1			
Thunder Bay	161,187				9				
Timiskaming	38,847								
Total - Northern	**796,654**			**2**	**24**	**1**	**1**		
Eastern Ontario	185,314		1		3				
Hastings-Prince Edward	143,790								
Kingston-Frontenac	175,568								
Leeds-Grenville	156,129								
Ottawa-Carleton	721,136	1	1		38		1		
Renfrew	97,634				1				1
Total- Eastern	**1,479,571**	**1**	**2**		**42**		**1**		**1**
Durham Region	458,616								
East York	107,822				4				
Etobicoke	328,718				8		1		1
Haliburton-Kawartha	165,039				7				
Muskoka-Parry Sound	78,675				3		1		
North York	589,653		2		24		1		
Peel Region	852,526		1		7	1	1		
Peterborough	123,448				9				
Scarborough	558,960		1		11				
Simcoe County	329,865						1		
Toronto City	653,734	3	1	2	11				
York City	146,534				1		1		
York Region	592,445				11		1		1
Total - Central East	**4,986,035**	**3**	**5**	**2**	**96**	**1**	**7**		**2**
Bruce, Grey-Owen Sound	153,312				6		1		
Elgin-St. Thomas	79,159								
Huron	60,220								
Chatham-Kent	109,650				1				
Lambton	128,975				2				
Middlesex-London	389,616		1	1	4				
Oxford	97,142				1				
Perth	72,106								
Windsor-Essex	350,329				11				
Total - Southwest	**1,440,509**		**1**	**1**	**25**		**1**		
Brant	114,564	1							
Haldimand-Norfolk Region	102,575			1	3		5		
Halton Region	339,875								1
Hamilton-Wentworth	467,799		1		17		1		1
Niagara Region	403,504		1		20				
Waterloo Region	405,435				18				1
Wellington-Dufferin	217,052		2		2		1		
Total - Central West	**2,050,804**	**1**	**4**	**1**	**60**		**7**		**3**
December 2000	**10,753,573**	**5**	**12**	**6**	**247**	**2**	**17**		**6**
*** Total YTD 2000**	**-**	**149**	**141**	**139**	**5,217**	**8**	**1,542**	**9**	**79**
*** Total YTD 1999**	**-**	**131**	**246**	**136**	**6,504**	**4**	**3,582**	**2**	**81**

* Adjusted for deletions and late reports.

Summary of Reportable Diseases in December, 2000

Health Units by Region	1996 Population	Mumps	Pertussis	Rubella	Salmon.	Shigellosis	Syphilis (Prim/Sec)	VTEC
Algoma	123,953							
North Bay	93,841							
Northwestern	80,235		4		1			
Porcupine	97,437		1					
Sudbury	201,154				1			
Thunder Bay	161,187				1			
Timiskaming	38,847							
Total - Northern	**796,654**		**5**		**3**			
Eastern Ontario	185,314				1			
Hastings-Prince Edward	143,790				7			
Kingston-Frontenac	175,568							
Leeds-Grenville	156,129				2			
Ottawa-Carleton	721,136		4		9	1		
Renfrew	97,634	1						
Total- Eastern	**1,479,571**	**1**	**4**		**19**	**1**		
Durham Region	458,616		4		2			
East York	107,822				2			
Etobicoke	328,718		3		1			
Haliburton-Kawartha	165,039				1			
Muskoka-Parry Sound	78,675							
North York	589,653		1		7			
Peel Region	852,526		2		11	2		
Peterborough	123,448		3		2			
Scarborough	558,960		1		3			1
Simcoe County	329,865				1			
Toronto City	653,734		3		7	1		
York City	146,534				2			
York Region	592,445		2		10			1
Total - Central East	**4,986,035**		**19**		**49**	**3**		**2**
Bruce, Grey-Owen Sound	153,312		1		5			
Elgin-St. Thomas	79,159							
Huron	60,220		1					
Chatham-Kent	109,650							
Lambton	128,975		2		3			
Middlesex-London	389,616	1			1			
Oxford	97,142							
Perth	72,106							
Windsor-Essex	350,329		2		1	1		
Total - Southwest	**1,440,509**	**1**	**6**		**10**	**1**		
Brant	114,564	1	4					
Haldimand-Norfolk Region	102,575				3			
Halton Region	339,875		1		2	1		
Hamilton-Wentworth	467,799				2	1		1
Niagara Region	403,504		2		4	1		1
Waterloo Region	405,435				7			1
Wellington-Dufferin	217,052		2		4			
Total - Central West	**2,050,804**	**1**	**9**		**22**	**3**		**3**
December 2000	**10,753,573**	**3**	**43**		**103**	**8**		**5**
*** Total YTD 2000**	**-**	**35**	**665**	**8**	**2,264**	**262**	**12**	**571**
*** Total YTD 1999**	**-**	**43**	**1,203**	**3**	**2,304**	**266**	**31**	**370**

* Adjusted for deletions and late reports.