

PORT COLBORNE

CHAP
COMMUNITY HEALTH
ASSESSMENT PROJECT

Study C Report:

**A comparison of hospital discharge patterns
among Port Colborne residents to those in a
series of Ontario reference communities**

Unapproved Final Report

19 October, 2004

Study C Report: Hospital Discharge Patterns

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FOREWORD

In December, 2003, the draft report entitled "A comparison of hospital discharge patterns among Port Colborne residents to those in a series of Ontario reference communities" was released by Ventana Clinical Research Corporation. The design and methods used in the preparation of that report followed a research protocol that had been developed with the assistance of an independent expert advisory committee and external consultants, and which was approved by the Technical Sub-Committee (TSC). The research protocol also underwent a thorough ethics review and approval process, and was received by the Public Liaison Committee of Port Colborne.

While Ventana Clinical Research Corporation followed the agreed upon protocol, the report released in December, 2003 had not been subject to review by the TSC, the community or other interested parties. The TSC coordinated this review process. Comments were received from the Ministry of the Environment, Regional Niagara Public Health Department, Stantec Consulting and the Ontario Ministry of Health. A review was also performed by INCO consultants including Dr. David Andrews, Dr. James Heller, and Mr. Don Carmichael. These individuals have expertise in biostatistics, public health, and hospital discharge records, respectively.

At the request of the TSC, and in consultation with Ventana, revisions have been made to the draft report in order to satisfy comments received from all stakeholders. The most important of these changes include:

- 1) A comparison of Port Colborne hospital discharge rates to rates in the 11 other Niagara communities.
- 2) Boxplots of the rate ratios generated from the analysis for each of Port Colborne, the comparison and the Niagara communities to show the distribution of rate ratios.
- 3) Two-sample t-tests of the individual community rate ratios estimated from the analysis were performed comparing Port Colborne to the group of comparison communities and Port Colborne to the group of Niagara communities.
- 4) The calculation of standardized discharge ratios for comparisons to Ontario.

We recommend that the findings from this study be integrated with those from the self-administered general health mail-out survey conducted among Port Colborne residents in 2003 (CHAP A Report: A Self-Reported Health Assessment of the Port Colborne Community (2003); *currently in preparation*). While the findings from both these studies are unable to determine causal relationships between environmental exposure to the chemicals of concern and human health in Port Colborne, they are useful tools in generating hypotheses for future research.

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The authors thank the Canadian Institute of Health Information (CIHI) for the use of data from the Discharge Abstract Database. We also gratefully acknowledge the Surveillance and Risk Assessment Division, Centre for Chronic Disease Prevention and Control at Health Canada for providing us aggregate counts of hospital discharges and, in particular, the technical assistance provided by Robert Semenciw. We are grateful to those who assisted in providing data concerning potential confounders, including Laine Ruus of the Data Library Service at the University of Toronto, Neil Johnston at the Ontario Physicians Human Resources Data Centre and the staff at the Gerstein Science Reference Library at the University of Toronto. We appreciate the help of the Ontario Ministry of the Environment in advising us on environmental contamination issues in Ontario communities. The authors thank the members of the Expert Advisory Committee for their input and support, and Dr. Doug Schaubel (Department of Biostatistics, University of Michigan) for his reviews and comments. We also acknowledge the technical assistance provided by Micheline Mistruzzi (CIHI).

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The opinions and conclusions expressed in this report have not been endorsed by any of the above-mentioned parties.

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ABBREVIATIONS

CBRA	Community-Based Risk Assessment
CHAP	Community Health Assessment Project
CI	Confidence Interval
CIHI	Canadian Institute for Health Information
CoC	Chemical of Concern
COPD	Chronic Obstructive Pulmonary Disease
CSD	Census Subdivision
DAD	Discharge Abstract Database
GLM	Generalized Linear Model
ICD-9	International Classification of Diseases 9 th Revision
MRDx	Most Responsible Diagnosis
MOE	Ontario Ministry of the Environment
MOH	Ontario Ministry of Health
OHS	Ontario Health Survey
SAS	Statistical Analysis System
TSC	Technical Sub-Committee

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EXECUTIVE SUMMARY

Background

The city of Port Colborne, Ontario is located on the northern shore of Lake Erie with a population of approximately 18,500 residents. Soil sampling conducted in the city by the Ontario Ministry of the Environment has found elevated levels of four chemicals of concern (CoCs): nickel, arsenic, cobalt and copper. This contamination has been attributed to the operation of an INCO nickel refinery between 1918 and 1984. Although a previous Ministry of the Environment report suggested that it is unlikely the observed levels of contamination could affect the health of Port Colborne residents, no study has directly evaluated the health of all residents. Continued community concerns about the potential human health effects resulting from this contamination led to the development of the Community Health Assessment Project (CHAP), an integrated series of health assessment studies. In this report, we characterize hospital discharge patterns for Port Colborne and compare these to what was reported for a group of Ontario communities and for the province of Ontario. The comparison was performed to determine whether hospital discharge patterns in Port Colborne are different than what may be expected, and to generate hypotheses to be addressed in possible subsequent research.

Methods

Our primary reference population consisted of a series of 35 Ontario communities. They were selected based on similarity to Port Colborne with respect to the joint distribution of a number of sociodemographic variables measured in four Canadian censuses (1981, 1986, 1991 and 1996). Many of these variables are recognized determinants of health, and have been previously used to identify regions for the purposes of comparing health outcomes between areas with similar sociodemographic characteristics. Those communities that were in close proximity to Port Colborne (<50 km) were excluded in the selection of comparison communities as we sought to restrict our reference group to communities whose residents were unlikely to have spent any time in Port Colborne. However, aside from this rationale, additional post hoc comparisons were undertaken in this study to compare discharge patterns among Port Colborne residents to those in nearby communities in the Niagara region, in order to put the results of the comparison to the 35 communities into a regional context. Communities with environmental concerns relevant to respiratory conditions were identified and assessed for their potential impact on the results obtained from the comparison communities. Although comparisons were also made to overall provincial rates, the use of the comparison communities allowed us to better evaluate the potential confounding role of several socio-demographic variables, albeit at an ecological level.

Aggregate counts of hospital discharges were extracted from the Discharge Abstract Database of the Canadian Institute for Health Information. These counts were tabulated for 18 different health conditions across strata defined by age group, sex, calendar year and

community. Provincial summary counts across these same strata were also obtained, and in conjunction with the discharge counts, are used to estimate discharge rates. Hospital discharges for the following health conditions, listed by ICD-9 chapters, were examined:

- All causes (001-999)
- Malignant neoplasms of respiratory and intrathoracic organs (160-165)
- Diseases of the nervous system and sense organs (320-389)
- Diseases of the circulatory system (390-459)
- Non-malignant diseases of the respiratory system (460-519)
- Diseases of the digestive system (520-579)
- Diseases of the genitourinary system (580-629)
- Diseases of the skin and subcutaneous tissue (680-709)
- Injury and poisoning (800-999).

Additional comparisons were performed for selected conditions contained within the defined disease groupings.

The aggregate number of hospital discharges for each health condition was provided for residents of 1) Port Colborne, 2) 35 comparison communities, 3) 11 communities in the Niagara region and 4) the province of Ontario.

Discharge counts were compared using annual age- and sex-specific population census estimates that were obtained for each community and for Ontario. For each health condition, Poisson regression, with correction for correlation in the data (where possible), was used to estimate the ratio of disease-specific discharge rates between the following regions:

- Port Colborne and the combined discharges from 35 Ontario comparison communities
- Port Colborne and the combined discharges from the 11 communities in the Niagara region
- Port Colborne and Ontario.

The comparison of primary interest was that which used the comparison communities as the referent group. This is mainly because these communities were matched to Port Colborne on several socio-demographic variables, and thus were better able to adjust for the potential confounding role that differences in these characteristics may have had on rate ratios.

One of the assumptions of Poisson-distributed data is that events occur independently of one another. However, hospital discharge events are not likely to be independent as an individual who is sick may be more likely to return to hospital for the same condition. In other words, hospital discharge events are likely to be correlated among individuals. Data analysis confirmed that there was correlation within the data, or that the data were overdispersed. In order to adjust the model for this overdispersion, a dispersion factor was included in the model (i.e. the dscale option). This option tends to widen confidence intervals, providing a more reasonable estimation of the standard error of the rate ratio.

All rate ratios were adjusted for the effects of age, sex and year. The 95% confidence intervals were calculated to assess statistically significant differences between regions. The regression models further evaluated the potential confounding role of other community level variables, including income, education, smoking prevalence and population-to-physician ratio. Although comparison communities were selected based on variables describing income and education, among others, variability between the comparison communities remained. Therefore, mean income and education were included in the regression analysis to account for residual effects not accounted for in the selection of comparison communities.

Age-, period- and sex-specific analyses were conducted and results are presented overall, across four age groupings (<20, 20-44, 45-64 and 65+ years of age), for males and females and for two calendar periods (1980 to 1989 and 1990 to 2000).

Additional box plot distributions were created post hoc to describe differences in hospital discharge rate ratios that existed between individual communities and to provide additional information for the interpretation of the study results. Box plots were constructed to illustrate the spread of the distribution of rate ratios obtained from comparing discharge rates in Port Colborne and each of the 35 comparison communities relative to the other communities combined. Similarly, separate box plots were created to describe the distribution of rate ratios for Port Colborne and each of the Niagara communities relative to the other communities combined. Two-sample t-tests, weighted by community size, were conducted with these rate ratios comparing Port Colborne to the comparison communities and Port Colborne to the Niagara communities.

Standardized discharge ratios were calculated post hoc for comparisons of hospital discharge rates among Port Colborne residents to Ontario residents. This standardized discharge ratio is the ratio of the observed rate in Port Colborne compared to the rate expected in Port Colborne if residents of this community had the same rates as those observed in Ontario. The standardized discharge ratio was calculated for hospital data including and excluding day surgeries. This analysis provided additional information for interpreting the results of the regression analysis, which is limited in its utility for comparing Port Colborne discharge rates to Ontario discharge rates.

Results

For the Port Colborne to comparison community analysis, overall and stratified analyses indicated that for several of the disease categories investigated, Port Colborne hospital discharge rates were lower than the rates in the comparison communities. A statistically significant adjusted rate ratio of less than one was found for the following disease categories in the overall analysis:

- all causes combined
- malignant neoplasms of the respiratory and intrathoracic organs
- diseases of the nervous system
- diseases of the circulatory system

- cerebrovascular disease
- diseases of the digestive system
- diseases of the genitourinary system
- non-malignant diseases of the respiratory system
- other diseases of the respiratory tract
- chronic obstructive pulmonary disease and allied conditions
- diseases of the skin and subcutaneous tissue
- injury and poisoning.

Stratified analysis of these conditions were consistent with the above and had either lower discharge rates or rates that did not have a statistically significant rate ratio. One exception was chronic obstructive pulmonary disease and allied conditions, which had a higher rate ratio in the youngest age group (<20 years).

Only a few of the disease categories investigated showed that Port Colborne hospital discharge rates were higher than the rates in the comparison communities. In the overall results, these conditions were:

- ischemic heart disease
- acute respiratory infections.

Stratified analyses indicated that Port Colborne had higher rates than those in the comparison communities for:

- ischemic heart disease (20-44 years, ≥ 65 years, both sexes and both periods)
- acute respiratory infections (≥ 20 years, both sexes and both periods)
- COPD and allied conditions (<20 years)
- asthma (<20 years, ≥ 65 years and 1990 to 2000).

The overall analysis of Port Colborne and the Niagara discharge rates showed that for most conditions, there was no difference in the rates between the two groups.

The overall analysis showed that Port Colborne hospital discharge rates were lower than the rates observed in the Niagara communities for four of the 18 disease categories:

- diseases of the nervous system
- diseases of the genitourinary system
- other diseases of the respiratory tract
- diseases of the skin and subcutaneous tissue.

Stratified analyses of these four conditions were consistent with the above, and indicated Port Colborne rates were either no different or lower than the other Niagara communities.

Port Colborne hospital discharge rates overall were found to be higher than the rates observed for the Niagara communities for three of the 18 disease categories:

- ischemic heart disease
- acute respiratory infections
- pneumonia/influenza.

Stratified analysis indicated higher rate ratios for several disease categories, including:

- all causes (1990 to 2000)
- malignant diseases of the respiratory system (20-44 years, 1980 to 1989)
- diseases of the circulatory system (≥ 20 years)
- ischemic Heart Disease (≥ 20 years, both sexes, both periods)
- acute myocardial infarction (45-64 years, males)
- cerebrovascular disease (males)
- acute respiratory infections (≥ 45 years, females, 1980 to 1989)
- pneumonia and influenza (20-44 years, females, 1990 to 2000)
- chronic obstructive pulmonary disease and allied conditions (< 20 years)
- asthma (< 20 years)
- injury and poisoning (20-44 years).

Box plots created post hoc show that Port Colborne rate ratios fall within the box encompassing the middle 50% of the rate ratios for all the comparison communities. In many instances, the Port Colborne rate ratios fell below the median rate ratio. This is consistent with the analysis results reported above. Two-sample t-tests comparing rate ratios indicate that Port Colborne's rate ratios for all disease categories, overall and stratified by age group, sex and study period were not statistically significantly different than those of the comparison communities. Similar results were observed for box plots and two-sample t-tests including data for the Niagara communities. T-tests, however, lack the sample size required for sufficient power to detect differences.

Ontario comparisons were varied. Over half of the results indicated that Port Colborne had a higher rate of discharges than the Ontario population. These results, however, were not adjusted for several potential confounding variables and the confidence intervals likely underestimate the error associated with the rate ratios, as they have not been adjusted for overdispersion in the data. Many of the results of the Ontario comparisons were consistent with the other comparisons.

Summary

Several study design limitations are considered in the interpretation of the results. These methodological considerations include the lack of data at an individual level and the inability to control for the effects of disease-specific risk factors. Regional differences in the treatment or management of disease likely contribute to important differences in hospital discharge rates. The data do not allow us to take into account residential mobility

patterns and, therefore, cannot identify those discharges that occurred among long-term residents in a given community. Finally, while we were able to control for the prevalence of smoking at a health region level, such adjustments were crude and it is possible that individual differences in smoking behaviours and exposure to environmental tobacco smoke may have contributed to some of our observed differences.

In general, hospital discharge rates for Port Colborne were found to be lower or no different than the comparison communities and the Niagara communities. Post hoc analyses are consistent in most instances with the initial results. Higher rates of hospital discharges were observed in both comparisons for ischemic heart disease and acute respiratory infections. Stratified analysis of chronic obstructive pulmonary disease and asthma identified higher rates of hospital discharges for the <20 years age group. The findings of these four disease categories were consistent across all methods of analysis, including the Ontario comparison.

The limitations within the study design (e.g., residual effects of important confounding variables) may contribute in part to the observed findings. Further, although the issue of multiple comparisons was not adjusted for in this study, it has been reported that observational studies that consider several exposures, outcomes and subgroups may be prone to finding spurious results. In many studies, 20% or more of the findings may be erroneous, rather than the expected 5% false positive associations ($p < 0.05$).

Finally, this study was designed to investigate whether hospital discharge rates for Port Colborne are different from what may be expected based on comparisons to suitable referent populations. In so keeping, differences observed highlight the need for considering these results in conjunction with those results from CHAP Study A and with the purpose of this study in the context of the entire suite of proposed CHAP studies.

Recommendations

Higher hospital discharge rates observed for Port Colborne for ischemic heart disease, acute respiratory infections, chronic obstructive pulmonary disease and allied conditions and asthma should be evaluated as potential candidates for further research.

Keywords: hospital discharge rates, environmental pollution, ecological study