Socioeconomic status (SES) and 30-day hospital readmissions for chronic obstructive pulmonary (COPD) disease:

a population-based cohort study

Supplementary File
Supplemental Text

Methods

Study Data Sources

The Registered Persons Database contains basic demographic information including sex and date of birth. The Ontario Health Insurance Plan Physician Claims database contains information on all services provided by fee-for-service physicians and “shadow-billings” for physicians paid under alternate payment plans. The Canadian Institute of Health Information Discharge Abstract database contains information on all acute care hospitalizations. These datasets were deterministically linked using unique encoded identifiers, with 100% success for the patients studied, and analyzed at the Institute for Clinical Evaluative Sciences. The study was approved by the institutional review board at Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada. The full dataset creation plan is available from the authors upon request.

Study Population

All individuals aged 35 or greater in Ontario who had one or more unplanned, acute care hospitalizations where COPD contributed significantly to length of stay between January 1, 2004 and November 30, 2014 were included. Unplanned hospitalizations were those where patients’ initial status was recorded as urgent or emergent. COPD hospitalizations were those with International Classification of Disease 10 codes J41-J44 as most responsible diagnosis or as an admitting diagnosis or pre-admit comorbidity that contributed at least 24 hours to a patient’s length of stay. Hospitalizations where patients were ineligible for Ontario healthcare insurance; where there were missing values on key measures such as patient identifier, discharge date or
discharge disposition; where length of stay was an outlier (greater than the 99th percentile); where patients were transferred to a second acute care hospital on discharge; or where patients died were excluded. Individuals could have more than one index hospitalization. Hospitalizations that occurred within 30 days of a previous hospitalization were considered readmissions and not index hospitalizations. The exception to this was in the calculation of repeated readmissions.

**Readmissions**

Readmissions with pregnancy, childbirth, or puerperium as the most responsible diagnosis were not considered. If there were multiple readmissions within the 30-day period, only the first was used to calculate and predict readmission rates. All, however, were counted to examine rates of multiple readmissions within 30 days. COPD-specific readmissions were considered in secondary analyses.

**Exposure Outcomes**

SES was characterized using the four domains of the validated Ontario Marginalization Index that capture processes by which individuals and groups are prevented from fully participating in society. Residential instability considers the proportion of people living in an area who are alone or youth, as well as number of persons per dwelling, number of people living in apartments, and number of people who are married. Material deprivation, another domain, considers the proportion of people with no high school graduation, who are from lone parent families, who are unemployed, and/or who are low income. Ethnic concentration considers the proportion of people who are recent immigrants and visible minorities. Finally, Dependency considers the ratio of seniors and children to working age adults and labor force participation.
Additional Analyses

To determine if results were consistent when the competing risk of death was not considered, we repeated the main analysis with the outcome of 30-day all-cause readmissions alone. To determine if COPD specific readmission differed from readmissions due to any cause, we performed additional analyses substituting the former for the later. Secondary analyses were completed examining readmission rates or death within 90 days and stratifying the primary analysis by younger (under 65 years) and older age.

Results

Additional Analyses

Risk factors for all-cause readmissions (but not death) and their magnitudes (including the four domains of SES marginalization and income quintile) were similar to the risk factors for all-cause readmissions and death except dementia was no longer a significant risk factor (Table 3). Risk factors for COPD-specific readmissions and their magnitudes (including the four domains of SES marginalization and income quintile) were largely similar to all-cause readmissions and death, except for comorbidities where only congestive heart failure, asthma and cancer were significantly associated with increased COPD readmissions. People age 65 and older seemed less affected by SES factors than those under 65 (e-Table 3). Some comorbidities but not socioeconomic factors appeared to be risk factors for 90 day readmissions or death. (e-Table 4).
## Supplemental Tables

### e-Table 1: Readmission rate or death among people with and without various comorbidities.

| Comorbidity                                | Readmission rate or death among people (%) | p-value |
|--------------------------------------------|-------------------------------------------|---------|
| Cerebrovascular Disease                    | 1,167 (23.6%)                             | 0.015   |
| Congestive Heart Failure                   | 14,443 (27.7%)                            | <.001   |
| Connective tissue / rheumatic disease      | 490 (21.5%)                               | 0.468   |
| Dementia                                   | 2,878 (26.6%)                             | <.001   |
| Diabetes without complications             | 5,504 (21.1%)                             | <.001   |
| Diabetes with complications                | 8,855 (26.8%)                             | <.001   |
| Hemiplegia or Paraplegia                  | 298 (26.5%)                               | <.001   |
| Mild Liver Disease                         | 529 (25.7%)                               | <.001   |
| Moderate or Severe Liver Disease           | 185 (36.3%)                               | <.001   |
| Acute Myocardial Infarction                | 3,778 (26.6%)                             | <.001   |
| Peptic Ulcer Disease                       | 263 (23.0%)                               | 0.498   |
| Peripheral Vascular Disease                | 1,532 (25.9%)                             | <.001   |
| Primary Cancer                             | 3,770 (30.5%)                             | <.001   |
| Metastatic Cancer                          | 1,888 (44.0%)                             | <.001   |
| Renal Disease                              | 4,317 (29.3%)                             | <.001   |
| Active Asthma                               | 12,853 (22.3%)                            | 0.511   |
| Respiratory failure                        | 4,487 (24.9%)                             | <.001   |
**e-Table 2.** Non-adjusted odds ratios (with 95% CI and p-values) of residential stability and various comorbidities and 30-day readmission or death individuals with chronic obstructive pulmonary disease

| Characteristics          | All-cause readmission or death | OR  | Lower 95% confidence interval | Upper 95% confidence interval | p-value |
|--------------------------|--------------------------------|-----|-------------------------------|-------------------------------|---------|
| Residential Instability  |                                |     |                               |                               |         |
| Lowest                   |                                | 1.00|                               |                               |         |
| Next least marginalized  |                                | 1.01| 0.97                          | 1.04                          | 0.7448  |
| Middle                   |                                | 1.00| 0.97                          | 1.03                          | 0.9888  |
| Next most marginalized   |                                | 1.03| 1.00                          | 1.07                          | 0.0482  |
| Most marginalized        |                                | 1.07| 1.04                          | 1.10                          | <0.0001 |
| Co-morbidities           |                                |     |                               |                               |         |
| Myocardial Infarction    |                                | 1.22| 1.18                          | 1.26                          | <0.0001 |
| Congestive Heart Failure |                                | 1.34| 1.32                          | 1.37                          | <0.0001 |
| Peripheral Vascular Disease |                            | 1.18| 1.12                          | 1.23                          | <0.0001 |
| Cerebrovascular Disease  |                                | 1.08| 1.02                          | 1.14                          | 0.0045  |
| Dementia                 |                                | 1.24| 1.20                          | 1.28                          | <0.0001 |
| Connective tissue / rheumatic disease |                | 0.97| 0.90                          | 1.06                          | 0.4968  |
| Ulcers of the Digestive System |                        | 1.05| 0.94                          | 1.17                          | 0.4222  |
| Mild Liver Disease       |                                | 1.14| 1.06                          | 1.23                          | 0.0008  |
| Diabetes without complications |                             | 0.94| 0.92                          | 0.97                          | <0.0001 |
| Diabetes with complications |                              | 1.26| 1.23                          | 1.29                          | <0.0001 |
| Hemiplegia or Paraplegia |                                | 1.21| 1.10                          | 1.34                          | 0.0002  |
| Renal Disease            |                                | 1.36| 1.33                          | 1.40                          | <0.0001 |
| Primary Cancer           |                                | 1.44| 1.40                          | 1.48                          | <0.0001 |
| Moderate or Severe Liver Disease |                   | 1.65| 1.46                          | 1.85                          | <0.0001 |
| Metastatic Cancer        |                                | 2.10| 2.02                          | 2.17                          | <0.0001 |
| Active asthma            |                                | 0.97| 0.95                          | 0.98                          | 0.0003  |
| Respiratory failure      |                                | 1.13| 1.10                          | 1.16                          | <0.0001 |
**e-Table 3.** Adjusted odds ratios (with 95% confidence intervals and p-values) of association between residential instability and various comorbidities and 30-day Readmission or death for individuals with chronic obstructive pulmonary disease, by age less than or over 65 years

| Characteristic  | Age less than 65 years |  |  |  | Age more than or equal to 65 years |  |  |  |
|-----------------|------------------------|---|---|---|-----------------------------------|---|---|---|
|                 | Odds Ratio             | Lower 95% confidence interval | Upper 95% confidence interval | p-value | Odds Ratio             | Lower 95% confidence interval | Upper 95% confidence interval | p-value |
| Residential Instability |  |  |  |  |  |  |  |  |
| Lowest          | 1.00                   | 1.00                           |  |  | 1.00                   | 1.00                           |  |  |
| Next least marginalized | 1.01                   | 0.90                           | 1.14 | 0.828 | 1.02                   | 0.97                           | 1.07 | 0.485 |
| Middle          | 1.00                   | 0.89                           | 1.11 | 0.952 | 1.00                   | 0.95                           | 1.04 | 0.909 |
| Next most marginalized | 1.05                   | 0.94                           | 1.16 | 0.407 | 1.01                   | 0.97                           | 1.05 | 0.691 |
| Most marginalized | 1.09                   | 0.99                           | 1.21 | 0.084 | 1.03                   | 0.99                           | 1.08 | 0.137 |
| Co-morbidity    |  |  |  |  |  |  |  |  |
| Myocardial Infarction | 1.19                   | 1.06                           | 1.34 | 0.005 | 1.14                   | 1.09                           | 1.19 | <0.001 |
| Congestive Heart Failure | 1.14                   | 1.06                           | 1.24 | 0.001 | 1.26                   | 1.23                           | 1.29 | <0.001 |
| Peripheral Vascular Disease | 1.05                   | 0.86                           | 1.27 | 0.633 | 1.15                   | 1.08                           | 1.23 | <0.001 |
| Cerebrovascular Disease | 0.90                   | 0.71                           | 1.14 | 0.372 | 0.94                   | 0.87                           | 1.02 | 0.131 |
| Dementia        | 1.10                   | 0.76                           | 1.60 | 0.617 | 1.13                   | 1.08                           | 1.19 | <0.001 |
| Connective tissue / rheumatic disease | 1.02                   | 0.79                           | 1.31 | 0.906 | 0.96                   | 0.85                           | 1.07 | 0.462 |
| Ulcers of the Digestive System | 1.05                   | 0.69                           | 1.58 | 0.833 | 0.97                   | 0.83                           | 1.14 | 0.708 |
| Mild Liver Disease | 1.23                   | 1.05                           | 1.44 | 0.009 | 1.07                   | 0.92                           | 1.23 | 0.401 |
| Diabetes without complications | 1.01                   | 0.94                           | 1.09 | 0.705 | 0.98                   | 0.95                           | 1.02 | 0.377 |
| Diabetes with complications | 1.18                   | 1.08                           | 1.28 | <0.001 | 1.10                   | 1.07                           | 1.14 | <0.001 |
| Hemiplegia or Paraplegia | 1.36                   | 0.97                           | 1.92 | 0.078 | 1.05                   | 0.89                           | 1.24 | 0.541 |
| Renal Disease   | 1.42                   | 1.23                           | 1.63 | <0.001 | 1.24                   | 1.19                           | 1.29 | <0.001 |
| Primary Cancer  | 1.95                   | 1.74                           | 2.19 | <0.001 | 1.57                   | 1.50                           | 1.65 | <0.001 |
| Moderate or Severe Liver Disease | 1.84                   | 1.39                           | 2.44 | <0.001 | 1.75                   | 1.35                           | 2.27 | <0.001 |
| Metastatic Cancer | 3.43                   | 2.92                           | 4.02 | <0.001 | 2.89                   | 2.69                           | 3.11 | <0.001 |
| Active asthma   | 0.98                   | 0.93                           | 1.03 | 0.389 | 0.94                   | 0.91                           | 0.96 | <0.001 |
| Respiratory failure | 1.04                   | 0.96                           | 1.12 | 0.377 | 1.10                   | 1.06                           | 1.15 | <0.001 |
**e-Table 4.** Adjusted odds ratios (with 95% confidence internal and p-values) of residential instability and various comorbidities and all-cause readmission or death within 90 days for individuals with chronic obstructive pulmonary disease

| Characteristic                          | Odds Ratio | Lower 95% confidence interval | Upper 95% confidence interval | p-value |
|----------------------------------------|------------|-------------------------------|-------------------------------|---------|
| **Residential Instability**            |            |                               |                               |         |
| Lowest (reference)                     | 1.00       |                               |                               |         |
| Next least marginalized                | 1.01       | 0.96                          | 1.06                          | 0.677   |
| Middle                                 | 0.99       | 0.94                          | 1.03                          | 0.538   |
| Next most marginalized                | 0.99       | 0.95                          | 1.04                          | 0.769   |
| Most marginalized                     | 1.02       | 0.98                          | 1.07                          | 0.269   |
| **Co-morbidity**                       |            |                               |                               |         |
| Myocardial Infarction                  | 1.15       | 1.10                          | 1.20                          | <0.001  |
| Congestive Heart Failure               | 1.26       | 1.23                          | 1.29                          | <0.001  |
| Peripheral Vascular Disease            | 1.15       | 1.07                          | 1.23                          | <0.001  |
| Cerebrovascular Disease                | 0.94       | 0.87                          | 1.02                          | 0.137   |
| Dementia                               | 1.11       | 1.05                          | 1.16                          | <0.001  |
| Connective tissue / rheumatic disease  | 0.97       | 0.87                          | 1.09                          | 0.604   |
| Ulcers of the Digestive System         | 0.99       | 0.85                          | 1.16                          | 0.886   |
| Mild Liver Disease                     | 1.18       | 1.05                          | 1.32                          | 0.006   |
| Diabetes without complications         | 1.00       | 0.96                          | 1.03                          | 0.873   |
| Diabetes with complications            | 1.11       | 1.08                          | 1.15                          | <0.001  |
| Hemiplegia or Paraplegia              | 1.11       | 0.95                          | 1.30                          | 0.185   |
| Renal Disease                          | 1.27       | 1.21                          | 1.32                          | <0.001  |
| Primary Cancer                         | 1.69       | 1.61                          | 1.76                          | <0.001  |
| Moderate or Severe Liver Disease       | 1.90       | 1.56                          | 2.31                          | <0.001  |
| Metastatic Cancer                      | 3.13       | 2.92                          | 3.35                          | <0.001  |
| Active asthma                          | 0.93       | 0.91                          | 0.96                          | <0.001  |
| Respiratory failure                    | 1.09       | 1.04                          | 1.13                          | <0.001  |
Explanation as to why this study does not have a Research Ethics Board Number

ICES is a prescribed entity under section 45 of Ontario’s Personal Health Information Protection Act (PHIPA). Section 45 is the provision that enables analysis and compilation of statistical information related to the management, evaluation and monitoring of, allocation of resources to, and planning for the health system. Section 45 authorizes health information custodians to disclose personal health information to a prescribed entity, like ICES, without consent for such purposes.

Section 45 contrasts with that of section 44 of PHIPA, under which projects require review by a Research Ethics Board. Although projects conducted wholly under section 45, by definition, do not require REB review, the REB at Sunnybrook Health Sciences Centre – ICES’ REB of Record – has agreed to help ICES achieve a higher ethical standard for the use of administrative and other data held at ICES. This is done using a retrospective review process whereby, at the end of each calendar year, ICES submits a report on the projects undertaken that year to the REB for review and approval. The REB may select individual projects from the report for review of the corresponding proposals and privacy impact assessments developed and archived at ICES. The above project was included in the 2012 annual report to the REB.

Because of the way the retrospective review process takes place, individual projects are not given approval numbers.

In addition to informing Sunnybrook’s REB of projects undertaken at ICES, the REB is aware that the Information and Privacy Commissioner of Ontario reviews ICES’ policies, practices and procedures for privacy protection and data security tri-annually. These include policies, practices and procedures that require review and approval of every project by ICES’ Privacy Office. ICES was approved by the Commissioner for a fourth time in 2014.