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Effect of social deprivation on the admission rate and outcomes of adult respiratory emergency admissions

Seán Cournane [a], Declan Byrne [b], Richard Conway [b], Deirdre O'Riordan [b], Seamus Coveney [c], Bernard Silke [b, *]

[a] Medical Physics and Bioengineering Department, St James's Hospital, Dublin 8, Ireland
[b] Department of Internal Medicine, St James's Hospital, Dublin 8, Ireland
[c] Envo-Geo Environmental Geoinformatics, Ireland

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ABSTRACT

Background: Patients with respiratory disorders constitute a major source of activity for Acute Medicine. We have examined the impact of Socio-Economic Status (SES) and weather factors on the outcomes (30-day in-hospital mortality) of emergency hospitalisations with a respiratory presentation.
Methods: All emergency respiratory admissions to St. James Hospital, Dublin, from 2002 to 2014 were evaluated. Patients were categorized by quintile of Deprivation Index, and evaluated against hospital admission rate (/1000 population) and 30-day in-hospital mortality. Univariate and multivariable risk estimates (Odds Ratios (OR) or Incidence Rate Ratios (IRR)) were calculated, using logistic or zero truncated Poisson regression as appropriate.
Results: There were 32,538 episodes in 14,093 patients, representing 39.5% of medical emergency episodes over the 13-yr period. Deprivation Quintile independently predicted the admission rate, with incidence rate ratios (IRR) of Q3 2.02 (95% CI: 1.27, 3.23), Q4 2.55 (95% CI: 1.35, 4.83) and Q5 5.68 (95% CI: 3.56, 9.06). The 30-day in-hospital mortality for the highest quintile was increased ($p < 0.01$), Q5 1.31 (95% CI: 1.07, 1.61). Particulate matter (PM_{10}) was predictive for the top two quintiles (>17.2 and 23.8 μg/m^3 respectively) with an OR for a worse outcome of Q4 1.22 (95% CI: 1.07, 1.40) and Q5 1.24 (95% CI: 1.08, 1.42). Weather (season) and the daily temperature did not affect the admission rate but were significantly associated with worse outcome.
Conclusion: Socio-Economic Status influences the admission rate incidence and hospital mortality of respiratory emergency admissions; local environmental conditions (air pollution and temperature) appear only relevant to the mortality outcomes.

1. Introduction

Socio-economic status (SES) has been correlated with the rate of hospital utilization and total healthcare costs [1]; increasing deprivation predicts the mortality in the general population [2,3]. These relationships have been confirmed for diverse disease such as alcohol-related [4], myocardial infarction [5], chronic heart failure [6] and colorectal cancer [7]. Furthermore, standardized mortality ratios increase in parallel with increasing deprivation for specific occupational groups [8].

The emergency medical admission rate is globally influenced by the socio-economic construct of a hospital's catchment area, affecting the hospitals workload and costs [9,10]. However, the subset of respiratory patients form a significant component of the emergency medical admission workload, amounting to 40% of all our emergency medical admissions - it is of interest to consider specific factors affecting the admission and outcomes of the large subset. We know that social inequality influences the hospital admissions rates for acute respiratory infections and pneumonia, these being higher for patients living in more disadvantaged areas [11]. Weather factors could be pertinent although precisely how temperature, humidity and air pollution interact to influence the rate of admission and healthcare outcomes is unclear [12]. Lower temperatures and humidity in temperate climates may increase the incidence of viral illness including influenza [13,14].

Other environment factors relevant to the respiratory admission

* Corresponding author.
E-mail address: bernardsilke@physicians.ie (B. Silke).

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may be the concentrations of sulphur dioxide and particulate matter, respectively [15]. Indeed, the literature reports that those patients from deprived backgrounds prove to be at a further higher risk from air pollution compared to persons living in less disadvantaged areas [16]. A previous study at our institution highlighted the link between significant increases in mortality and urban air pollution [17]. Legislation enacted in 1990 banned the marketing, sale and distribution of bituminous coals and, subsequently, the air quality in the area improved resulting in a decrease of black smoke concentrations by approximately 35.6 μg/m^3. Thereafter, the adjusted non-trauma death rates saw a 5.7% reduction, with 15.5% and 10.3% reductions observed for respiratory and cardiovascular deaths, respectively [18]. While the beneficial effects of air quality interventions are clear, there is still a suggestion that air pollution below the accepted international standards may have detrimental effects on health, particularly for those with respiratory conditions [15,19–21].

We know that SES, independent of co-morbidity or acute illness severity, is a powerful predictor of admission rate incidence [10] and outcomes [22] for acute medical admissions to our institution. We now consider the largest group of emergency medical admission when 'on-call' – the respiratory admissions accounting for up to 40% of all our emergency medical admissions. We have examined the social circumstances and physical conditions of their areas of residence within the hospital catchment area, including socio-economic status and environmental conditions (weather and air particulate matter), and related these to the admission rate incidence and hospital mortality outcomes while controlling for patient acuity and co-morbidities.

2. Methods

2.1. Background

St James's Hospital operates a continuous sectorized acute general medical 'take' for emergency admissions in its Dublin catchment area of 270,000 adults. All unselected emergency medical admissions between 2002 and 2014 (13-year period) were admitted to the Acute Medical Admissions Unit (AMAU), which has been described elsewhere [23,24].

2.2. Data collection

The data collated within the patient database includes information for each clinical episode extracted from the patient administration system, the national hospital in-patient enquiry (HIPE) scheme, the patient electronic record, the emergency room and other laboratory systems including microbiology, haematology and biochemistry. HIPE is a national database of coded discharge summaries from acute public hospitals in Ireland, run by the Economic and Social Research Institute [25].

On admission, recorded data included the patients' unique hospital number, admitting consultant, date of birth, gender, area of residence by county, principal diagnosis, up to nine additional secondary diagnoses, procedures (principal and up to nine additional secondary procedures) and admission and discharge dates. Additional information contained in the database included physiological, haematological and biochemical parameters. During and following the admission, HIPE data of all coded diseases at time of discharge/death, together with procedures and investigations undertaken during the hospital stay was included.

The Republic of Ireland reports analyses of census returns based on the Electoral Division (ED) - the smallest administrative areas for which population statistics are available. Small Area Populations Statistics (SAPS) are available for 3409 EDs. Using principle components analysis (PCA), a weighted combination of four indicators, relating to unemployment, social class, type of housing tenure and car ownership was derived, as described by the SAHRU investigators [26]. The methodology has previously been described in detail [22] where the Deprivation Index Scores were ranked from low (least deprived) to high (most deprived) and divided into quintiles according to their ranked raw scores. This attribute data were joined to the small area polygon geometries based upon their relative geographic positions using the ArcGIS Geographic Information System software [27].

2.3. Air quality

Over the study period (2002–2014), data from three stations within the hospital catchment area was assessed with daily measurements recorded for PM_{10} [28]. The daily levels were separated into equally divided quintiles, the cut values of which were 10.0, 13.5, 17.2 and 23.8 μg/m^3, respectively.

2.4. Confounding factors

Deranged hemodynamic and physiological admission parameters may be utilised to derive an Acute Illness Severity Score [29,30] with such aggregate score systems used to adjust univariate estimates of risk for other major outcome predictors, as described previously [31,32]. The Acute Illness Severity Score, Charlson Co-Morbidity Index [33], and Chronic Disabling Disease [34] the sepsis status [35] together with the Quintiles of the Deprivation index were included in a stepwise logistic regression model as described using 30-day in-hospital mortality as the primary endpoint in this study.

A respiratory patient was defined as a patient whom had been referred to the pulmonary function laboratory for formal testing (20.7% of total episodes) or with either a primary or secondary discharge diagnosis of chronic obstructive pulmonary disease (26.1%) or of pneumonia (6.7%); this gave a total of 39.5% of episodes of respiratory type.

2.5. Statistical methods

Descriptive statistics were calculated for demographic data, including means/standard deviations (SD), medians/interquartile ranges (IQR), or percentages. We examined 30-day in-hospital mortality as the primary outcome.

For hospital admission rates, we employed a truncated Poisson regression model, including predictive outcome categorical variables in the model as a series of indicator variables. The dependent variable of the admission rate is a count variable and restricted to certain values; the predictor variables are therefore regressed against admission rates using the truncated Poisson model. We used robust standard errors for the parameter estimates, as recommended by Cameron and Trivedi [36]. The Poisson regression coefficients are the log of the rate ratio: the rate at which events occur is called the incidence rate. Thus, with the truncated Poisson regression model, we can interpret the coefficients in terms of incidence rate ratios (IRR). We used the margins command in Stata 13.1 to estimate and interpret adjusted predictions for sub-groups, while controlling for other variables such as illness severity, using computations of average marginal effects. Margins are statistics calculated from predictions of a previously fitted model at fixed values of some covariates and averaging or otherwise over the remaining covariates.

Logistic regression analysis was used to examine all significant outcome predictors on 30-day in hospital mortality. Adjusted Odds ratios (OR) and 95% confidence intervals (CI) were calculated where