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ORIGINAL ARTICLE

Hospital admissions for chronic obstructive pulmonary disease in New Zealand

Richard J Milne, Richard Beasley

Abstract

Aim To determine the number, distribution and cost of hospital admissions for chronic obstructive pulmonary disease (COPD) in New Zealand.

Methods National patient-level routine data on admissions with a principal diagnosis of COPD (mostly ICD-10-AN J440 & J441) were obtained for the period July 1st 2008 to June 30th 2013. Admissions with length of stay (LOS) \geq 90 days were excluded.

Results There were 61,516 admissions in 5 years. Admission rates and budget impact (in 2012/13 dollar values) were stable but the average length of stay (ALOS) declined from 5.09 to 4.37 days. In FY2012/13 the admission rate was 2.82 per 1000 population, with age standardised rate (ASR) 4.4- and 3.6-fold higher for Māori and Pacific peoples respectively than for European/others. For age \geq 15 years the ASR was 2.55 per 1000. Admission rates were higher for men than women and increased steeply with age and socioeconomic deprivation (NZDep06). The mean age at discharge was lower for Māori and Pacific peoples than for European/Others (63.4, 67.1 and 72.3 years). The mean 30-day readmission rate was 6.7%. The average LOS increased with age and was shorter for Māori (3.6 days) and Pacific peoples (3.5 days) than for European/Others (4.7 days). Admission rates varied widely across District Health Boards, and were higher in rural than urban regions. The estimated cost of admissions in FY2012/13 was \$NZ59.6m.

Conclusions Hospital admissions for COPD are costly and are over-represented in high risk groups including rural, elderly, socioeconomically deprived and Māori and Pacific peoples. Effective interventions that are targeted to high risk groups are required to improve equity and reduce the burden of COPD.

Chronic obstructive pulmonary disease (COPD) is an important non-communicable disease in New Zealand with a high prevalence, morbidity and risk of mortality.¹ It was the fourth leading cause of deaths in New Zealand in 2009, responsible for 6% of deaths.² COPD is also a common comorbidity of hospitalisation for people admitted for other reasons, adding to the length of stay.³

Rates of hospitalisation for Māori are more than double those for non-Māori and it is not known to what extent this represents a greater incidence of COPD amongst Māori, or greater severity of disease, or a different threshold for admission.⁴ Evidence-based interventions that improve the quality of life and/or reduce the need for hospital admissions and risk of mortality are a high priority.

Due to its high morbidity and mortality, COPD places a large burden on the healthcare system. The main direct cost to the healthcare system is hospital admissions, largely for exacerbations, which are responsible for around two-thirds of the total cost.³

Because hospital admissions are easily identified, they are useful to measure both the trends in the burden of COPD and its associated costs. This is particularly important in New Zealand, which has one of the highest COPD hospital admission rates in the OECD.⁵

The main purpose of this descriptive study was to analyse national hospital admissions for COPD over a 5-year period, in order to estimate the 5-year trends and distribution by age, prioritised ethnicity, socio-economic status, length of stay and district health board (DHB). A secondary purpose was to estimate the impact of these admissions on the public healthcare budget.

Methods

A nation-wide data set of anonymised publicly funded hospital admissions with a principal clinical diagnosis of COPD (ICD-10-AM J40, 439, 440, 441, 448, 449, 410, 411, 42, 432, 438) was obtained from the Ministry of Health, for the period July 1 2008 to June 30 2013 financial years FY2008/09 to 2012/13). Admissions with a length of stay >90 days were excluded in an attempt to avoid biasing the mean costs and the average length of stay (ALOS). An index admission in FY2012/13 was defined as an admission for a patient who had not been admitted for COPD in the previous 4 years. The data included age, sex, prioritised ethnicity, District Health Board (DHB), length of stay (LOS), deprivation index (NZDep06), patient complication and morbidity level (PCCL), Australian Refined Diagnosis Related Group (AR-DRG) version 6.0, case weight and seasonality.

Multiple ethnic groups were prioritised using the following hierarchy: Māori, Pacific, European/Other. Population denominators were obtained from either the 2006 or 2013 census (Statistics NZ) with linear interpolation where required for intermediate years. Day stays were defined as having zero length of stay. The time to a repeat admission for COPD was defined as the number of days from the date of discharge from an index admission to the date of the next admission for COPD, excluding same day readmissions and transfers between hospitals.

Diagnosis Related Groups (AR-DRGs) are a patient classification system used by the NZ Ministry of Health to structure episodes of care into groups that are clinically similar both in terms of patient characteristics and health interventions, and that are therefore anticipated to consume comparable levels of hospital resources.

The 'NZDep' is a small geographical area-based index of socioeconomic deprivation calculated from each 5-yearly census based on the following variables: income, employment, communication, transportation support, educational and other qualifications, home ownership and household crowding. It is arranged in (approximately equal) deciles, with '1' representing the least disadvantaged and '10' representing the most disadvantaged. Individuals were assigned a domicile code based on their home address at the time of admission, which was then mapped to the New Zealand deprivation index (NZDep06).⁶

Admission costs were computed using admission-specific diagnosis related group (DRG) case weights applied to FY2012/13, in which the national price for a hospital admission was \$NZ4614 (NZ Ministry of Health). No attempt was made to obtain numbers of patient presentations or costs for Outpatient Clinic or Emergency Department visits because this information is not specific to the indications under study.

The severity of each hospital admission was estimated using PCCLs which are a measure of the cumulative effect of a patient's complications and comorbidities⁷ which were available for FY2009/10 to FY2012/13.

Age adjustment for FY2012/13 was conducted by the direct method using the census 2013 population (Statistics NZ) and the World Health Organization standard population.⁸ Analysis of variance was used to test for equality of means and a skewness/kurtosis test for normality. The time to a readmission following discharge from an index admission was analysed using Kaplan-Meier failure analysis, excluding same-day readmissions (LOS=0). In order to capture all readmissions within 12 months of discharge, the period of analysis was July 1, 2011 to June 30, 2012. For a comparison of DHBs, in order to capture all readmissions within 30 days of a discharge the period of analysis was June 1, 2012 to May 31, 2013.

All analyses were conducted using Stata v12.1 software (StataCorp LP, 4905 Lakeway Drive, College Station, Texas 77845-4512, USA).

Results

Admissions over 5 years—There were 62,183 hospital admissions including day stays over the period July 1, 2008 to June 30, 2013 with a principal diagnosis of COPD. Excluding admissions with a length of stay greater than 90 days (1.8%) there were 61,516 admissions, 12% of which were day stays and 2.2% received non-invasive ventilation. The annual admission rate was stable across the 5-year period, with a budget impact in 2012/13 dollars of \$59.6m, while the ALOS declined (Table 1).

Table 1. Hospital admissions with a principal diagnosis of COPD in the period July 1st 2008 to June 30th, 2013 and corresponding costs

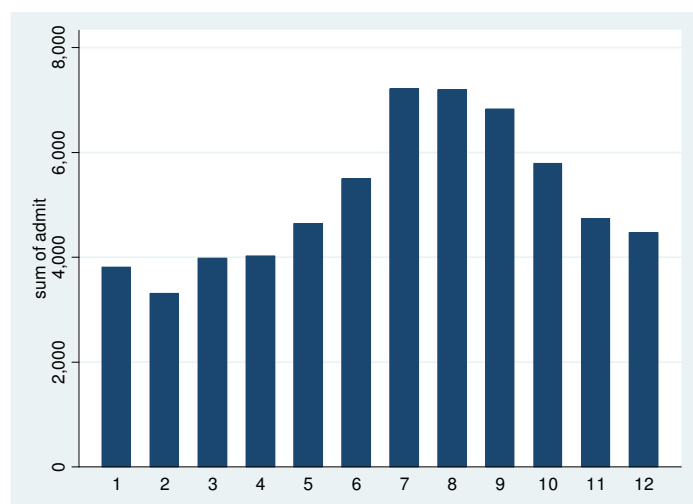
| ICD10 AN | 2008/9 | 2009/10 | 2010/11 | 2011/12 | 2012/13 | All years |
|------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| J40 | 667 | 589 | 575 | 683 | 622 | 627 |
| J439 | 60 | 69 | 53 | 64 | 67 | 63 |
| J440 | 6672 | 6803 | 6773 | 7411 | 7484 | 7021 |
| J441 | 3701 | 3790 | 3502 | 3522 | 3317 | 3564 |
| J448 | 221 | 188 | 149 | 179 | 188 | 185 |
| J449 | 804 | 845 | 830 | 802 | 687 | 793 |
| Other ^a | 45 | 56 | 52 | 49 | 53 | 51 |
| Total | 12,170 | 12,330 | 11,941 | 12,657 | 12,418 | 61,516 |
| Rate per 1000 | 2.90 | 2.91 | 2.78 | 2.91 | 2.82 | 2.86 |
| Day stays | 11.1% | 11.7% | 11.7% | 12.9% | 12.6% | 12.0% |
| ALOS (days) | 5.09 | 4.94 | 4.69 | 4.49 | 4.37 | 4.71 |
| Cost \$(m)^b | \$58.90 | \$61.30 | \$60.10 | \$59.40 | \$59.60 | \$59.70 |
| Mean cost \$(m)^b | \$4862 | \$4968 | \$5036 | \$4673 | \$4799 | \$4852 |

ALOS=average length of stay (P<0.05); admissions with a length of stay >90 days were excluded.

^a ICD10 J410, 411, 42, 432, 438.

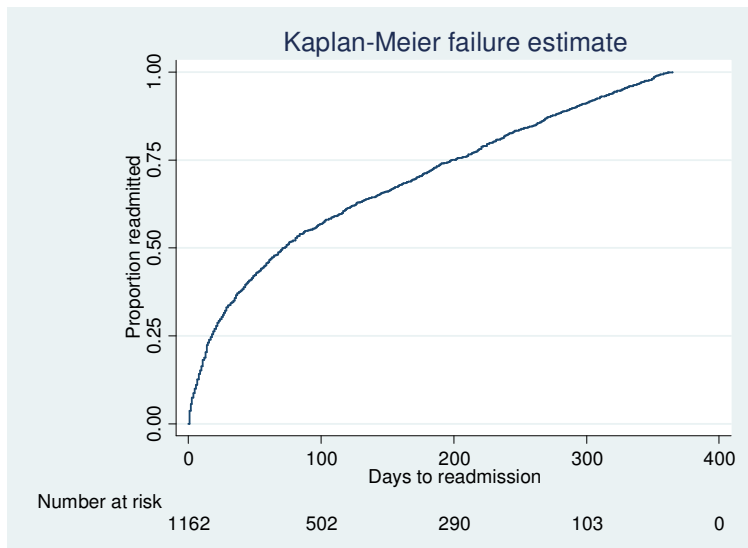
^b In 2012/13 dollars.

Seasonality—Hospital admissions peaked in winter and were lowest in late summer (Figure 1).

Figure 1. Admissions by month (January=1) in the period July 1, 2008 to June 30, 2013

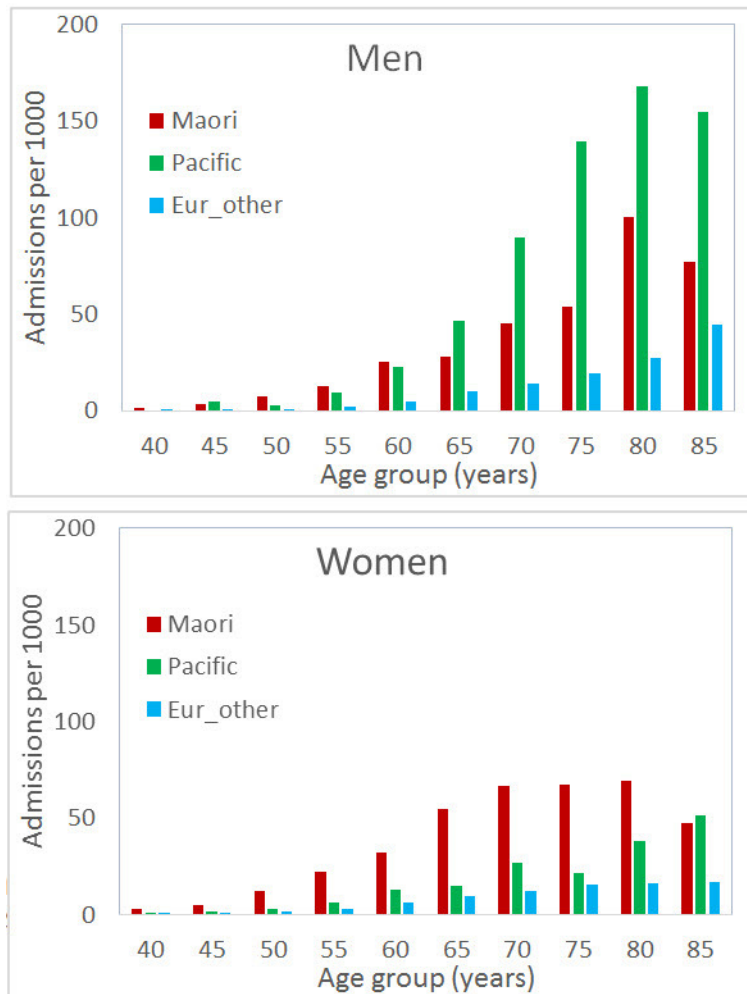
Repeat admissions—In order to estimate the probability of repeat admissions within 12 months, a Kaplan-Meier failure analysis was conducted, based on first-ever (index) admissions discharged in the period July 1, 2011 to June 30, 2012. There were 5032 index admissions in this period, 1162 of which (23%) led to a readmission within 12 months of discharge and 385 of these (33%) were readmitted within 30 days of discharge (Figure 2).

Figure 2. Time to readmission for all new patients who were readmitted within 12 months of discharge



Regression analysis showed that the time to a first readmission for COPD decreased with age ($P < 0.01$) and the severity of the index admission (PCCL; $P < 0.05$) but did not appear to be directly influenced by ethnicity or deprivation index or the day of discharge (not shown).

Admission rates were higher for men than women and increased steeply with age. They were much higher for Māori and Pacific peoples than European/Others, reaching over 150 per 1000 for elderly Pacific men (Figure 3).

Figure 3. Admission rates per 1000 population for men and women in FY2012/13

Denominator: 2013 Census (Statistics NZ)—The age-standardised admission rate (ASR) in FY2012/13 was 4.4-fold higher for Māori and 3.6-fold higher for Pacific peoples than for European/other ethnicities; and for individuals with age ≥ 15 years (the standard measure for international comparisons) it was 2.55 per 1000 (Table 2).

Table 2. COPD admission rates by the major ethnic groups in FY 2012/13

| Ethnicity | Admissions | Rate per 1000 | ASR ^a | Rate ratio ^b |
|---------------------|------------|---------------|------------------|-------------------------|
| Māori | 2423 | 4.03 | 6.14 | 4.41 |
| Pacific | 763 | 3.15 | 4.96 | 3.56 |
| European/Other | 9,232 | 2.59 | 1.39 | 1.00 |
| Total | 12,418 | 2.82 | 1.91 | n/a |
| Age ≥ 15 years | 12,334 | 3.14 | 2.55 | n/a |

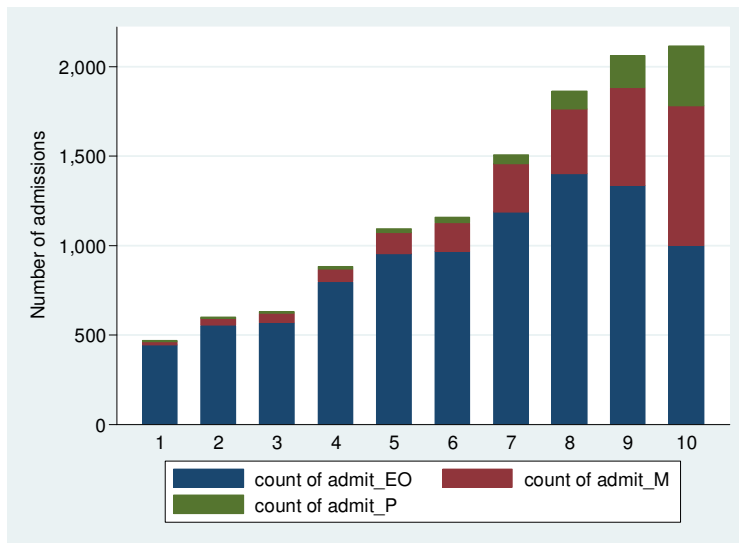
^a Age standardised to the WHO population.⁸

^b Relative to European/Other, age standardised.

In FY2012/13, the number of admissions for all three ethnic groups increased steeply with socioeconomic deprivation and the proportions of Māori and Pacific peoples also increased with deprivation.

Admissions for patients in NZDep06 decile 10 (the most deprived group) were more than 4-fold higher than those in decile 1 (Figure 4). There was no clear relationship between socioeconomic deprivation (NZDep06) and 30-day readmission rate ($p=0.62$).

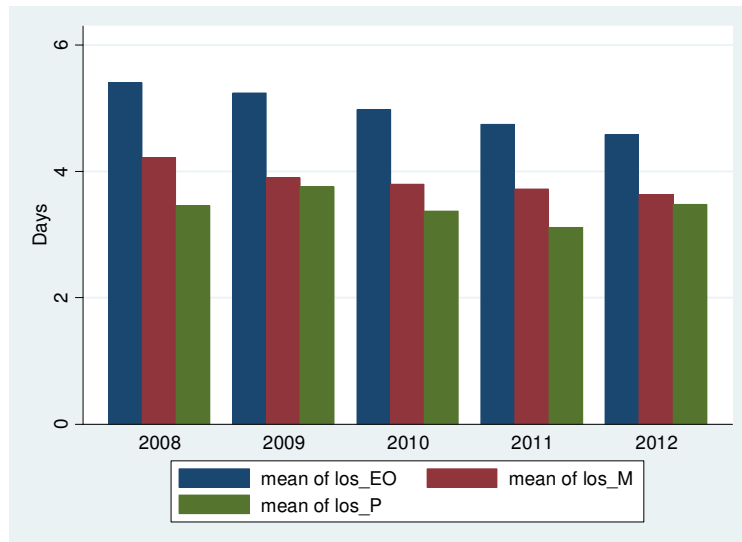
Figure 4. Admissions by ethnicity and socioeconomic deprivation in FY2012/13



Abscissa: NZDep06 (10=most deprived decile).

Legend: admit_M=Māori; admit_P=Pacific; admit_EO=European/Other.

Length of stay—Over the 5-year study period, the ALOS was consistently higher for European/Others than for Māori or Pacific peoples ($p<0.001$). It declined for European/Others and Māori but did not change appreciably for Pacific peoples (Figure 5).

Figure 5. Trends in the average length of stay over 5 years, by ethnic group^a

Abscissa: financial years 2008/09, 2009/10, 2010/11, 2011/12, 2012/13.

Legend: los_M=Māori; los_P=Pacific; los_EO=European/Other.

^a Includes day stays.

The overall decline was from 5.09 to 4.37 days (difference 0.72 days; $p < 0.001$). In FY 2012/13 the ALOS was shorter for Māori (3.59 days) and Pacific peoples (3.48 days) than for European/Others (4.65 days) [$p < 0.001$].

Regression analysis showed that the LOS increased with age and severity (PCCL) and was higher for women than men ($\beta > 0$; $P < 0.001$), but declined slightly with the level of socioeconomic deprivation ($\beta < 0$, $P < 0.05$; Table 3). There was no significant interaction between ethnicity and deprivation level (not shown).

Table 3. Regression analysis on length of stay in FY2012/13

| LOS | β^a | Std. Err. | t | P>t | -95% CI | +95% CI] |
|-------------------|-----------|-----------|--------|-------|---------|----------|
| Age (years) | 0.039 | 0.004 | 10.460 | 0.000 | 0.032 | 0.047 |
| PCCL ^b | 0.807 | 0.029 | 28.200 | 0.000 | 0.751 | 0.864 |
| Ethnicity | 0.402 | 0.064 | 6.290 | 0.000 | 0.276 | 0.527 |
| Sex (F=1) | 0.393 | 0.095 | 4.160 | 0.000 | 0.208 | 0.579 |
| NZDep06 | -0.039 | 0.019 | -2.090 | 0.036 | -0.076 | -0.003 |
| Day of week | 0.013 | 0.024 | 0.560 | 0.578 | -0.034 | 0.061 |

Adjusted $R^2 = 0.085$.

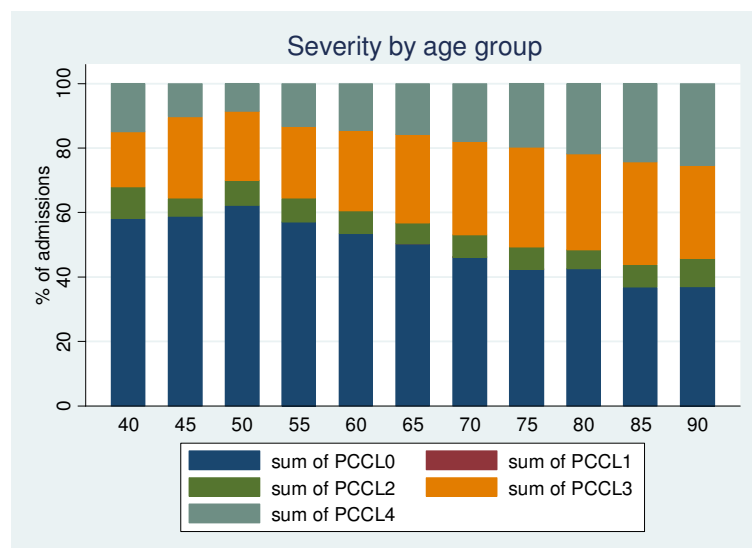
^a Regression coefficient.

^b PCCL=Patient complication and morbidity level (0 to 4; see Methods).

Severity of admission—Based on ‘patient complication and morbidity levels’ (PCCLs), about half of all admissions in 2012/13 were for the least severe cases (PCCL0) and the distribution of severity showed no substantial change over the 4 years of available data (not shown).

Higher age groups had higher proportions of more severe cases (Figure 6). Māori and European/Others had similar proportions of PCCL0 but Pacific peoples had slightly lower proportions (not shown).

Figure 6. Distribution of levels of severity (PCCL) by age group in FY2012/13



Comparison of District Health Boards—There was considerable variation in admission rates across the 20 DHBs. Predominantly rural regions including Wairarapa, Whanganui, Lakes District, Northland and West Coast had higher admission rates than urban regions. There was a 2.3-fold difference in admission rates between Wairarapa DHB and Auckland DHB in 2012/13. The ALOS (including day stays) also differed considerably across DHBs, with a range of 3.5 to 6.1.

The proportion of readmissions occurring within 30 days of discharge from an index admission varied from 4.1% in Auckland to 10.7% in Northland. The budget impact of admissions including day stays varied in proportion to the number of admissions, with a national total of \$59.62m (Table 4).

Table 4. Admissions, admission rates, 30 day readmissions, average length of stay and budget impact by District Health Board (DHB) in FY2012/13

| DHB | Admissions | Patients | Admission rate ^a | ALOS (days) | 30-day readmissions ^b | Budget impact (\$M) |
|--------------------|------------|----------|-----------------------------|-------------|----------------------------------|---------------------|
| Auckland | 869 | 343 | 2.14 | 4.85 | 4.1% | \$4.24 |
| Bay of Plenty | 729 | 320 | 3.73 | 4.66 | 4.4% | \$3.50 |
| Canterbury | 1336 | 436 | 2.86 | 5.19 | 6.9% | \$8.14 |
| Capital & Coast | 641 | 224 | 2.40 | 4.22 | 8.0% | \$2.99 |
| Counties Manukau | 1264 | 451 | 2.92 | 3.66 | 4.4% | \$6.14 |
| Hawke's Bay | 547 | 215 | 3.68 | 5.11 | 10.2% | \$3.16 |
| Hutt Valley | 447 | 167 | 3.28 | 3.88 | 8.4% | \$2.06 |
| Lakes | 426 | 136 | 4.33 | 3.88 | 6.6% | \$1.83 |
| MidCentral | 473 | 176 | 2.97 | 4.08 | 4.5% | \$1.91 |
| Nelson Marlborough | 288 | 130 | 2.19 | 4.17 | 10.0% | \$1.20 |
| Northland | 639 | 271 | 4.28 | 3.90 | 10.7% | \$3.02 |
| South Canterbury | 171 | 58 | 3.17 | 6.12 | 8.6% | \$0.95 |
| Southern | 963 | 352 | 3.36 | 4.94 | 6.0% | \$4.60 |
| Tairāwhiti | 135 | 53 | 3.04 | 5.05 | 7.5% | \$0.67 |

| DHB | Admissions | Patients | Admission rate ^a | ALOS (days) | 30-day readmissions ^b | Budget impact (\$M) |
|--------------------------|---------------|-------------|-----------------------------|-------------|----------------------------------|---------------------|
| Taranaki | 378 | 140 | 3.62 | 3.52 | 5.0% | \$1.50 |
| Waikato | 1,193 | 414 | 3.51 | 3.62 | 6.8% | \$5.21 |
| Wairarapa | 189 | 79 | 4.89 | 3.97 | 7.6% | \$0.81 |
| Waitemata | 1,275 | 488 | 2.64 | 4.63 | 7.8% | \$5.76 |
| West Coast | 132 | 54 | 4.21 | 4.02 | 5.6% | \$0.57 |
| Whanganui | 280 | 102 | 4.48 | 3.84 | 5.9% | \$1.12 |
| Missing | 43 | 29 | n/a | 8.62 | 10.3% | \$0.22 |
| Total^c | 12,418 | 4638 | 3.07 | 4.37 | 6.7% | \$59.62 |

ALOS=average length of stay.

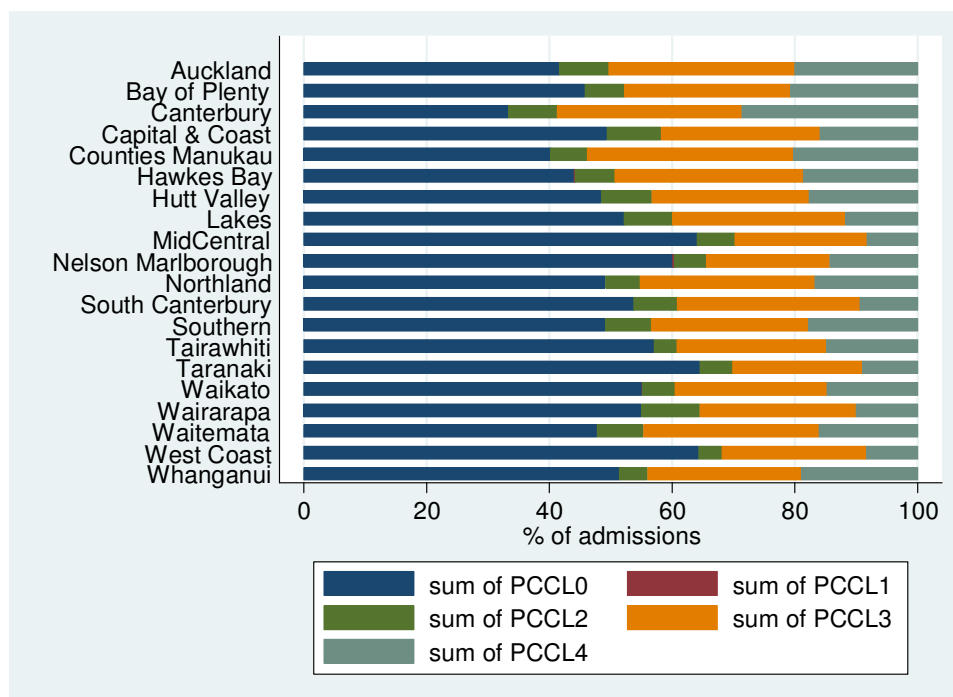
^a Unadjusted admissions per 1000 population.

^b Readmission within 30 days of a discharge from an index admission in June 1, 2012 to May 31, 2013.

^c Excludes 7 admissions with DHB missing and/or patient overseas.

Taranaki, Mid Central, Nelson-Marlborough and West Coast DHBs had the highest proportions of least severe cases (PCCL0) and Canterbury the lowest (Figure 7).

Figure 7. Distribution of admissions by 'patient complication and morbidity level' (PCCL) across District Health Boards in FY2012/13



PCCL0=least severe; PCCL4=most severe.

Discussion

This study has demonstrated that COPD is a major public health problem in New Zealand, with a substantive burden due to hospital admissions. In FY2012/13 there were 12,418 admissions with a principal diagnosis of COPD and a length of stay less than 90 days. This is approximately 1.2% of all publicly funded admissions in NZ.⁹ The burden is disproportionate for Māori and Pacific peoples and for men and women with lower socioeconomic status and the elderly and rural populations.

The age standardised admission rate for European/Others is lower than the unadjusted rate because of the preponderance of relatively elderly people compared to the WHO standard population.⁸ However, the reverse is true for Māori and Pacific peoples because of their relatively high mortality. The ASR for patients ≥ 15 years of age in FY2012/13 (2.55 per 1000) is third only to Hungary (3.64 per 1000) and Ireland (3.10 per 1000) for the same age group in 2011 OECD statistics.⁵

The mean age at discharge in 2012/13 was lower for Māori and Pacific peoples than for European/Others (63.4, 67.1 and 72.3 years respectively, $p < 0.001$), although the magnitude of the difference was not as great as that reported from a study from Waikato Hospital in 2004 (Māori versus non Maori, 57 and 72 years, respectively). These findings suggest that the disease progresses more rapidly in the Māori and Pacific populations, possibly due to greater exposure to risk factors for COPD including but not limited to tobacco and marijuana smoking, occupational exposures, childhood respiratory illnesses and asthma, which are likely to play a role.^{1,4,11} These risk factors are also likely to contribute to the higher prevalence of COPD for Māori and Pacific peoples. Mortality from COPD is 70% higher for Māori than for others,¹² consistent with the much higher hospital admission rates observed in our study.

Recent policy in the United States is to use 30-day readmission rates following an index hospitalisation for a COPD admission as an accountability measure on which funding is based.¹³ Recent international studies have reported 30-day readmission rates ranging from 8% to 18% in different settings.¹⁴⁻¹⁶ The mean rate of 6.7% for NZ in 2012/13 is low by comparison. While hospital quality of care is only one of several factors associated with 30-day readmission rates, these New Zealand figures suggest internationally favourable hospital management.

Over the 5-year study period the average length of stay declined by 0.72 days, due largely to a decline for European/Others. This appears to represent a real clinical gain rather than a gradual fall in the threshold for admissions, because the distribution of severity was stable. It is unclear why this gain was not achieved for Pacific peoples. The average length of stay varied considerably across DHBs but it is an imperfect measure of relative performance because of differing admission thresholds and age/ethnicity/ deprivation case mix.

The duration of a hospital stay for COPD can depend partly on the day of the week on which the patient was admitted,¹⁷ but this was not evident when our analysis was adjusted for other variables. The average length of stay (ALOS) was shorter for Māori and Pacific peoples than for European/Other ethnic groups, partly because of a higher proportion of day stays.

It is possible that, because of economic disadvantage, Māori and Pacific peoples have a greater tendency to present directly to the Emergency Department than to a general practitioner for mild exacerbations of COPD. Also, these groups have relatively low proportions of elderly men and women, who have a longer ALOS. Another possible contributor to the lower length of stay for some disadvantaged groups could be a lower severity threshold for admissions. However this seems unlikely for Māori and Pacific peoples, because they had similar distributions of severity as European/Others.

There was a strong socioeconomic gradient in hospital admissions for all 3 main ethnic groups. Overseas studies suggest that most of such differences can be explained by the associations with tobacco smoking or exposure to environmental tobacco smoke.^{18,19}

The NZ healthcare environment, where patients pay to access primary health care but not Emergency Department attendance or hospital admission, may provide an unintended incentive to increasing attendance to hospital, which then leads to an admission. Likewise, ethnic disparities in hospitalisation rates reflect not only prevalence /severity of COPD but also differences in access to primary care, and difference in perception of the care delivered in different healthcare settings. Higher admission rates in rural based DHBs could reflect poorer access to out-of-hours primary care, or a lower threshold for referral to hospital due to concerns about remoteness.

The distinct seasonal pattern of COPD admissions that has also been reported by researchers abroad²⁰ suggests that environmental interventions could reduce admissions and reduce hospital expenditure. Respiratory viruses, which are more active in winter, could contribute to exacerbations of COPD.²¹ Work is now being undertaken in New Zealand on the effects of home heating²² and the impact of air pollution on respiratory admissions.²³

COPD is the most common ambulatory sensitive (preventable) hospitalisation in adults. Some admissions for exacerbations of COPD are potentially preventable by improved access to primary care; although admission rates for a basket of chronic conditions including COPD were stable in the period 2001 to 2009, during which a capitated funding model improved access.²⁴

Further interpretation of hospital admission data is dependent on the accuracy of coding. This is likely to have been similar across the time period studied, although the identification of admissions for a small minority of patients less than 30 years of age does raise the issue of the validity of COPD as the primary cause of admission in this group.

COPD is a costly respiratory disease, with at least 12,418 hospital admissions attributed directly to COPD in FY2012/13, costing the DHBs \$59.9M (mean cost per admission \$NZ4799). Researchers in the United States have reported a mean cost of \$US2928 (\$NZ3501) for a 'standard' hospital admission for COPD in 2010 and \$US33,440 for admissions requiring intensive care.²⁵ Admissions with other principal diagnoses that could have been complicated and/or prolonged by COPD comorbidity were excluded from the analysis because this would lead to double counting (especially of cardiovascular admissions) and their contribution to hospital costs cannot be determined; therefore the total budget impact of COPD is likely to have been underestimated. It has been reported that COPD and cardiovascular disease are the most common comorbidities that complicate hospital admissions in NZ.³

In addition, our estimate of the budget impact of COPD is conservative because it is based on DRG case weights and it excludes outpatient appointments, emergency care, and admissions with a length of stay greater than 90 days, which will contribute disproportionately to the cost. Additional direct medical costs to DHBs including GP consultations, community pharmaceuticals and disability care were also outside the scope of this study.

A study in the United States reported that individuals with COPD consumed over 3-fold more healthcare resource than a matched control group.²⁶ Medical costs to the community include caregiver support, which can be substantial, and loss of earnings by patients and their families. Community interventions that reduce the risk of COPD admissions and the acuity of other admissions could have an important impact on the healthcare budget.

An international model showed that treatments that reduce the risk or severity of exacerbations are likely to be cost effective among those patients who have frequent exacerbations and hospitalisations.²⁷ Our findings suggest that in addition to patients with multiple hospital admissions, Māori and Pacific peoples and those of low socioeconomic status represent important priority groups for such interventions. These may include both established community interventions such as smoking cessation and pulmonary rehabilitation programmes^{28,29} and cost effective novel interventions such as long term high flow nasal humidification therapy.^{30,31}

In conclusion, hospital admissions for COPD are costly, and are over-represented in high risk groups including rural, elderly, socioeconomically deprived and Māori and Pacific peoples. Effective community interventions that are targeted to high risk individuals have the potential to improve equity and reduce the humanistic and economic burden of COPD.

Competing interests: Nil.

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