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The cost of treating patients with COPD in Denmark - A population study of COPD patients compared with non-COPD controls

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Summary
This paper describes a population-based study of health care resource use of patients with chronic obstructive pulmonary disease (COPD) compared to non-COPD controls. Through a screening of the Danish Patient Registry for patients admitted with COPD diagnoses for a 5-year period, 1998–2002, 66,000 individuals with COPD still alive at the beginning of 2002 were identified. Their use of health care resources in 2002 were compared with equivalent data, stratified for age, sex and mortality rates, for a control population without COPD based on data for the 300,000 remaining patients on the Danish Patient Registry in 2002. Results indicated that the gross cost of treating patients with COPD in the Danish somatic hospital and primary health care sector corresponded to 10% of the total cost of treating patients of 40 years or more. The net cost for COPD patients was 1.9 billion DKK (256 million €), 6% of the total annual costs of treating the population of 40 years or more. The gross cost related to any disease and the net cost reflected the resource use which could be attributed to COPD and its related diagnoses. The incidence of inpatient hospital admissions was almost four times higher in the COPD population than in the control group. COPD patients contacted their general practitioner 12 times more per year than non-COPD controls, but for specialist and paramedic treatment in the primary care sector there was no significant difference between COPD patients and non-COPD controls. Only one third of the COPD costs were due to treatment of COPD as the primary diagnosis. The remaining

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two-thirds of the COPD-related costs were mainly due to admissions for other diseases such as cardio-vascular diseases, other respiratory diseases, and cancer.

Introduction

Chronic obstructive pulmonary disease (COPD) is a major cause of chronic morbidity and mortality throughout the world. COPD is a disabling, progressive lung disease, characterised by increasing breathlessness, exacerbations, immobility and anxiety about suffocation, resulting in slowly decreasing quality of life over time. The prevalence of COPD is substantial and increasing. Globally, 9.3 per 1000 men and 6.3 per 1000 women are estimated to have the disease.[1] The disease leads to frequent emergency hospital admissions due to the exacerbations, and overall, the burden of COPD on the health care sector is significant and has been described and documented in previous studies.[2–9]

The main reason for developing COPD is tobacco smoking, which in addition to COPD also causes cancer and cardio-vascular diseases. Because of this and owing to the fact that the impairment of the lungs has an influence on other vital organs, co-morbidity is an important feature of a COPD patient. For example, COPD patients have an increased risk of right-sided heart failure, coronary heart disease, lung cancer and other lung diseases, such as pneumonia.[10] Although large in number, previous cost-of-illness studies of COPD are disease- or diagnosis-specific, as they have considered treatment for COPD only. Since they often fail to include the co-morbidity aspects, there is a risk that they have underestimated the real impact of COPD on the use of health care services. Furthermore, some studies are bottom-up studies in which resource use is self-reported or collected from patient records,[2,4] a data collection method which is only practically manageable with a relatively small sample size. This study provides a supplement to these studies as it included both co-morbidity aspects of the disease and involved a total count of patients and their resource use.

The present study tracked a population of COPD patients retrospectively for one year and compared this population with a control group without COPD with regard to the use of health care resources. Through direct standardisation of the control group data, using the COPD population as a reference, the net difference between the two groups was then calculated. This difference constitutes the real resource use that can be attributed to COPD and its co-morbid diagnoses. The method has previously been used to estimate the cost of treating patients with osteoarthritis in managed care organisations in the USA.[11–14]

In an international context, the Danish comprehensive administrative registers provide ideal possibilities for studying patient populations from register data. Owing to the existence of a personal identification code, every entry in the Danish registers on the use of health care services has a reference to a specific person. Thereby, in principle, the use of health care resources for each individual person as well as the entire population can be traced through the registers. The National Patient Registry contains information about hospital admissions and discharges, including in-patient and day case, ambulatory care, and length of stay. In addition, the register has a recording of diagnoses based on the ICD 10 classification.

The Health Care Reimbursement Scheme Registry contains information on the individual use of primary health care services, contacts to general practitioners and other primary care specialists, reimbursement information and fees. This register does not contain information on diagnoses. The Register of Medicinal Product Statistics contains information about the sale of OTC products, individual purchases of prescribed medicines and reimbursement from public funds. The Causes of Death Registry has a registration of all deaths in Denmark and the underlying causes of death. This register was not yet fully updated for the year studied, 2002. The Register of Medicinal Product Statistics was not open for register analysis in the year of our study. Our study focused on data from the two first registers and thus included the costs related to hospital admissions and treatment in the primary sector, but not the costs of the medical treatment outside hospitals.

By use of a number of COPD diagnoses combined with the personal identification code we studied and compared the use of health care resources based on data from the National Patient Registry and the Health Care Reimbursement Registry, with regard to hospital admissions and primary care contacts to privately practising health professionals for the population with COPD and the population without COPD in 2002.

Methods

Identification of COPD population

The individuals with COPD were identified through a search in the Danish Patient Registry and included in the COPD population if they:

- had at least one case of admission to a hospital with a COPD diagnosis,[15,16] defined as chronic bronchitis without specification (J42.9), emphysema pulmonum (J43*.*), other chronic obstructive lung diseases (morbus chronicus pulmonum obstructivus alius) (J44*.*) during the 5-year period of 1998–2002. This included both primary and secondary diagnoses;
- had at least one contact with the health system in 2002 e.g. hospital admission or primary care consultations;
- were at least 40 years of age on 1 January 2002.

Furthermore, for each of the identified individuals, the register was screened 1 year forward from the last contact in 2002. The individuals who had a contact after the last contact in 2002 were assumed to be alive and thus included in the study for the entire year of 2002. In the base case

scenario, aiming at estimating the total cost of COPD in 2002, the individuals who did not have a contact 1 year after the last contact in 2002 were only included in 2002 from 1 January to the date of the last contact in 2002 assuming they were dead. Furthermore, in another scenario, the average cost and resource use per person year were calculated. In this scenario, data for these individuals were included 1 year back from the last contact in 2002. Sensitivity analyses were conducted to assess the robustness of results, of different mortality rates in the COPD and control group, and the impact of controlling for diagnoses not related with COPD. In the initial screening of the National Patient Registry, ''the last contact'' was used as a proxy for mortality, as the registries were not updated with regard to death dates. Two years after the initial search in the registries, we validated this assumption through a new search in the National Patient Registry for the exact death dates of the COPD individuals identified. This is covered further in the discussion.

The control group was considered as the Danish population aged 40 years or more who did not meet the inclusion criteria for the COPD population. The control group accounted for health care resource use in 2002 for app. 2.5 million persons, of whom app. 300,000 were admitted to hospitals with other diagnoses than COPD. About 2.4 million individuals (97.4% of the control population) had contacts to general practitioners and specialists in the primary health care sector.

The resource use in 2002 was estimated in terms of hospital bed days, day case admissions, visits to GPs and primary care specialists, DRG-price per discharge,[17] and fee for consultations and treatment at primary care providers such as general practitioners, specialists and paramedics.[18]

The control group means were multiplied by the number of persons in the different COPD age groups for men and women, respectively, to calculate the total costs and resource use in the control group in a direct standardisation using the COPD population as a reference group.[19,20]

Results

Population characteristics

Table 1 shows the characteristics of the COPD population identified during 1998–2002. Of the 66,107 persons with COPD identified, 53% were women.

A total of 8566 persons or 13% of the population had the last contact in the registers in 2002 and in the base-case scenario, their use of health services was included only for the period up to their last contact.

A total of 34,339 persons or 52% were admitted to hospital for inpatient treatment at least once during 2002 and 46,205 or 70% had at least one case of hospital ambulatory care. A total of 11,587 or 18% were admitted to hospital with COPD as the primary diagnosis, and all, more than 99%, contacted their GPs and specialists in the primary health care sector in 2002.

Inpatient admissions

Table 2 below shows the mean number of inpatient admissions, bed-days and length of stay for the two populations, COPD and controls in an age-standardised comparison.

Men with COPD were admitted to inpatient treatment 1.4 times per year, or more than 3 times as often as the control population without COPD (0.4 times), and women 4 times as often (1.24 times vs. 0.31 times). This comparison included patients who were not admitted for inpatient treatment during the year of study. For patients who were admitted at least once for in-patient treatment during the year of study, patients with COPD were on average admitted 2.61 times (men) and 2.38 times (women) and the equivalent figures for the inpatients in the control group were lower, that is 1.85–1.68 times for men and women, respectively. The average number of bed-days attributable to COPD was 7.51 days for men and 7.72 for women, and the average length of stay was slightly longer for admitted COPD patients than for admitted patients without COPD, that is 0.52 days longer for men with COPD, and 0.66 days for women.

Co-morbidity

The COPD patients admitted for inpatient hospital treatment in 2002 accounted for a total of 78,427 admissions. Of these admissions, only 24.3% were due to COPD as the primary diagnosis. 13.5% of the admissions were due to other respiratory diseases (ICD 10 groups J00–J99), 7.3% to tumours (including cancer ICD 10 groups C00–D48) 16% to cardiovascular diseases, including ischemic and pulmonary heart diseases (ICD 10 group I00–I99). Thus, a total of 61% of the admissions in the COPD population were due to COPD and related disease groups as the primary diagnosis.

For day case, ambulatory hospital treatment, the picture was slightly different. Eleven percent of the 261,415 ambulatory visits had COPD as the primary diagnosis and COPD and related diseases mentioned above constituted only 35% of the total number of visits.

In Table 3 below, we calculated the incidence per 1000 persons for inpatient hospital admissions with different primary diagnoses for the COPD population and the population without COPD. As expected, the incidence of inpatient hospital admission with COPD in the control group was 0. The number of admissions for the COPD population for almost all diagnoses was at least twice as high as the control group incidences. In particular, the incidence for admission with respiratory diseases (J00–J99) was 11 times higher, and for ischemic heart diseases almost three times higher.

Primary care contacts

Table 4 shows contacts to general practitioners, other specialists and paramedics in the primary health care sector. When compared, a difference between the COPD population and the non-COPD population was seen in the number of contacts with the general practitioner. These contacts consisted of consultations at the GP office, emergency visits to the patient's home and telephone consultations with the GP. There were more than 10 GP contacts on average for men and more than 12 contacts for women attributable to COPD. For consultations with other specialists, there was no difference between the groups and thus no COPD attributable resource use.

Table 1 COPD population, patients admitted in total, patients admitted with COPD as the primary diagnosis, no. of persons with last contact in 2002.

	No. of persons with COPD (alive 01/01/2002)	No. of persons with COPD admitted in 2002 (in-patient)	No. of patients in out-patient hospital care with COPD	No. of patients with the primary diagnosis COPD, 2002	No. of persons with last contact in 2002
Men					
40–45 years	568	184	367	42	29
45–49 years	1104	380	739	89	49
50–54 years	1650	644	1142	163	111
55–59 years	2856	1210	2023	334	216
60–64 years	3233	1480	2294	463	278
65–69 years	4386	2218	3188	739	475
70–74 years	5688	3082	4214	996	781
75–79 years	5625	3353	4043	1164	961
80–84 years	3863	2422	2571	820	863
85+ years	2331	1508	1351	407	678
Total men	31,304	16,481	21,932	5217	4441
Women					
40–45 years	647	221	448	62	17
45–49 years	1293	486	904	125	29
50–54 years	1949	744	1429	247	89
55–59 years	3132	1306	2254	443	161
60–64 years	3710	1684	2727	665	267
65–69 years	5007	2421	3666	1002	476
70–74 years	6132	3298	4397	1308	729
75–79 years	5816	3341	4111	1237	901
80–84 years	4177	2571	2748	836	748
85+ years	2940	1786	1589	445	708
Total women	34,803	17,858	24,273	6370	4125
Women %	53	52	53	55	48
Total COPD	66,107	34,339	46,205	11,587	8,566

Table 2 Number of in-patient admissions, age-standardised means per person year, men and women, 2002.

In-patient admissions 2002 mean figures	Men			Women		
	COPD	Controls (std)	COPD attributable	COPD	Controls (std.)	COPD attributable
In-patient admissions per person in total population	1.40	0.39	1.01	1.24	0.31	0.93
In-patient admissions per admitted patients*	2.61	1.85		2.38	1.68	
Beddays per person in total population	10.28	2.77	7.51	10.15	2.43	7.72
Length of stay (mean per patient)	7.32	6.80	0.52	8.15	7.49	0.66

*The comparison with the control group has deliberately not been undertaken, as these populations are different from the ones originally compared.

Costs

Table 5 below shows the results of the base-case scenario, that is, the total cost of treating persons with COPD, the equivalent costs of treating non-COPD controls, and the net cost which was attributable to COPD patients in Danish Kroner (DKK). ''Costs'' include public expenses based on DRG prices and prices used under the health care reimbursement scheme.[17,18] Patient co-payments and outpatient medical expenses in the primary health care sector were not included. The total COPD cost of 2987 million DKK (401.6 million €, exchange rate from May 2002) amounted to 10% of

Table 3 Number of in-patient admissions per 1,000 persons in population, per primary diagnosis, 2002.

Comorbidity, incidence of in-patient admissions 2002, COPD and control group	No. with primary diagnosis per 1000 persons	
Diagnosis groups	COPD	Control (age-sex-standardised)
A00–B99: infectious, incl parasitic diseases	23	7
C00–D48: tumours	100	51
D50–D89: diseases in blood and blood producing organs and certain diseases relating to immune system	20	8
E00–E90: endocrinous and nutrition related diseases and metabolic diseases	28	10
F00–F99: mental and behavioural diseases and disturbances	13	3
G00–G99: diseases in nervous system	14	8
H00–H59: eye diseases	7	4
H60–H95: diseases in ear and processus mastoideus	2	1
I00–I99: cardiovascular diseases excl. I20–I28	133	50
I20–I25: ischaemic heart diseases	73	26
I26–I28: pulmonary heart disease and diseases in lung circuit	5	1
J00–J99: diseases in respiratory organs excl. COPD	177	15
J42–J44 (ekskl. J43.0): COPD	327	0
K00–K93: diseases in digestive organs	82	31
l00–l99: skin and cutaneous diseases	8	3
M00–M99: muscular-skeletal and connective tissue diseases	42	22
N00–N99: diseases in urinary and sex organs	42	21
O00–Q99: pregnancy, delivery, maternity, perinatal diseases, malformations, etc.	1	1
R00–R99: symptoms and abnormal findings not classified elsewhere	67	24
S00–T98: lesions, poisonings and certain other consequences of external exposure	64	31
Z00–Z99: factors of significance for health state, and contacts to health care services	90	30

Table 4 Contacts to general practitioners, other specialists and paramedics in the primary sector, and spirometry examinations, age-standardised means per person year, men and women, 2002.

No. of contacts, visits and examinations per person year, 2002	Men			Women		
	Men COPD	Controls (std)	COPD attributable	Women COPD	Controls (std.)	COPD attributable
GP consultations (visits to)	8.1	4.7	3.4	8.3	5.0	3.3
GP telephone consultation	9.3	3.9	5.4	12.2	5.3	6.9
Visit emergency GP	2.4	0.7	1.7	2.8	0.7	2.1
GP consultations total	19.8	9.3	10.5	23.3	11.0	12.3
Spirometry examinations	0.3	0.039	0.261	0.3	0.04	0.26
Consultations at other specialists etc.	3.5	3.7	−0.2	4.7	4.5	0.2

the total costs of hospital and primary sector care for patients of 40 years or more in Denmark in 2002. The net cost of 1927 million DKK (256 million €) amounted to 6% of the DK total costs. The number of persons accounting for these costs, app. 66,000, constituted 2.6% of the Danish population of 40 years of age or more. The main part of COPD attributable costs was spent on hospital care (97%). Primary care contacts only accounted for 3% of the attributable costs.

Table 6 represents the second scenario: the average costs per person year for COPD and controls and the cost per person year to be attributed to COPD. Individuals with the last contact in 2002 were included 1 year back from the last contact in 2002, so that all individuals accounted for an entire year.

For the COPD population the median cost per person year was 22,742 DKK (3058 €), the 75% percentile was 62,082 DKK (8348 €) and the 95% percentile was 196,132 DKK (26,372 €). For the control population, crude un-standardised figures showed a median of DK 1841 (248 €), 75% percentile of 6300 DKK (847 €) and a 95% percentile of 55,527 DKK (7466 €).

Table 5 Attributable cost of COPD, 2002, DKK.

	COPD			Controls (age—standardised)			Attributable to COPD
	Men, DKK	Women, DKK	Total, DKK	Men, DKK	Women DKK	Total DKK, kr.	Total DKK
Hospital	1394 mio.	1.390 mio.	2784 mio.	485 mio.	436 mio.	920 mio.	1863 mio.
Primary care	88 mio.	114 mio.	203 mio.	61 mio.	78 mio.	139 mio.	64 mio.
Total	1482 mio.	1504 mio.	2.987 mio.	546 mio.	513 mio.	1,059 mio.	1.927 mio.

Table 6 Average cost per person year for COPD population and non-COPD controls, DKK, 2002.

	COPD		Controls (age—standardised)				Attributable to COPD
	Men DKK	Women DKK	Both sexes, DKK	Men DKK	Women DKK	Both sexes DKK	Both sexes DKK
Hospital	49,399	43,911	46,580	16,478	13,143	14,744	31,836
Primary care	3052	3503	3289	2078	2318	2203	1086
Total	52,451	47,414	49,869	18,556	15,461	16,947	32,922

Robustness, validation and sensitivity analysis

This study was based on a total count of the health care resource use of all individuals in Denmark of 40 years or more as their data were entered in the two registers. The statistical certainty is per se much greater than in studies based on sampled data. Therefore, results were considered to be robust.

For the COPD population, we estimated an approximate date of death from the date of the last contact in the registers, and for the control group we used general Danish population data on mortality from Statistics Denmark. The COPD approximated mortality rate in 2002 was 13%, and the control group mortality was 4%. The significance of controlling for differences in mortality rates for the base-case scenario resulted in an additional DKK 250 million (33.6 million €) to be attributed to the COPD side, or an increase in COPD attributable costs of 13%.

In 2005, dates of death in 2002 and 2003 (all causes of death) were updated in the personal identification register. A merge between this register and our data file from the Patient Registry in 2005 provided the exact death dates of the identified individuals. This dataset showed that 90% of the individuals with the last contact in 2002 did in fact die in 2002. Although the approximated date of death (the last contact) is assumed to be premature, as patients do not always die at hospital or leaving the doctor's consultation, our assumption that the last contact to health services can be used a proxy for death dates of COPD patients was to a large extent reasonable. Furthermore, despite slight differences in the definition of the disease, these results were consistent with another Danish study.[21]

The other sensitivity analysis excluded costs of treating diagnoses which were not considered relevant for COPD. These diagnoses were within the ICD 10 groups H, L, N, O, P, Q, S and 10, comprising ear, eye and skin diseases, urinary and venereal diseases, maternity care, lesions and poisoning. The significance of excluding these diagnosis groups was 140 million DKK (18.8 million €) less on the COPD side equivalent to a reduction in the attributable costs of COPD of 7%.

Discussion

This study estimated the net resource use of persons with COPD in Denmark compared with persons without COPD in 2002. The underlying assumption of the study design was that if COPD has once been diagnosed in a patient, the patient will have this disease until death. Therefore, had the patient once been registered with this diagnosis in the National Patient Register, we could trace the pattern of health care resource use retrospectively from the inclusion date until the study ended or the patient died. The main purpose of this study was to look at the resource use for one specific year, but there is scope for more research into the longitudinal patterns of health care resource use for these patients.

The study's strengths are the availability of register data attached to each individual, which were aggregated into 5-year age groups, the total count of individuals, and the case-control design allowing us to consider co-morbidity aspects. We found that the cost of managing COPD patients was almost three times that of managing diseases in the control group without COPD. Co-morbidity in COPD patients played a significant role and had great impact on the costs of treating COPD patients.

Although the gender-related COPD attributable costs were almost identical, there were more women (53%) than men in the identified COPD population. This may seem surprising, as globally, the prevalence of COPD is higher in men than in women. There may be several reasons for the excessive number of women in the Danish COPD population. For many decades, Danish women have had a relatively high and—until a few years ago—increasing smoking prevalence compared to women internationally.[22] Furthermore, studies

based on Danish data have suggested that women are more sensitive to tobacco exposure than men and therefore their relative risk of developing smoking-related diseases, like COPD, is higher than that of men.[23–25] Our population-based study supports the findings of these clinical studies.

A limitation of the study is that it only included individuals who were admitted to hospital with a COPD diagnosis during the screening period (1998–2002). This means that a number of persons with COPD, who did not consult the health care system about their underlying disease in the screening period, or did so prior to 1998 and not again since, were not included on the COPD side of the calculation but on the control side. These individuals were considered to have COPD in a mild or moderate stage which did not yet require hospitalisation, and therefore one may assume that their annual use of the health care system was only slightly higher compared to the average control group individual. If this assumption was reasonable it would not affect the COPD attributable costs, only the number of persons in each group and the average cost per person year.

Another relevant issue is that of the methods and type of data chosen. The study relies entirely on the entries and coding of diagnoses of the administrative data system (the National Patient Registry). As misclassifications of patients may occur, there is a risk that some of the COPD ''related diseases'' and thus some attributable costs may result from misclassifications or erroneous coding. However, the choice of inclusion period, 1998–2002, may have minimized this risk. Before this period, the coding practices in Denmark may have been slightly different and going further back in the registries would have increased the risk of misclassification.

This study only considered part of the relevant socio-economic costs of COPD. The cost of medicines, long-term nursing care, personal assistance and patient co-payments are examples of direct health costs which were not included. Furthermore, we did not estimate the present value of production losses to society resulting from premature deaths of COPD patients, early retirement and sick days from work. Had these direct and indirect costs been included, the estimated impact of COPD on society would have been much higher. Thus, the cost of COPD estimated in this analysis is conservative. However, the exclusion of relevant cost components was made deliberately, to ensure that all data included in the study were consistent and comparable.

The study used DRG-prices and fees for consultations to estimate the value of resource use which, theoretically speaking, do not constitute the real cost of the services. However, DRG-prices in Denmark are calculated on the basis of historic costs from hospitals and frequently up-dated, and only fees for consultation in the primary health care sector are negotiated prices. As these fees only accounted for 3% of the total net COPD costs, we consider the analysis more cost-based than price-based and thus consistent with theoretical recommendations.

As to the choice of scenarios, we estimated the total costs of one accounting year (2002) in the baseline scenario, and adjusted for the excessive (approximated) mortality in the COPD population in the second scenario, in order to calculate an average cost per full patient year with COPD. As people leave the population, others enter the population, and it may be argued that this adjustment is not fully justified as terminal patients may be over represented. However, as individuals did not enter the COPD population until we found them in the register with a COPD diagnosis related to a hospital admission, and as COPD does not develop instantly but is slowly progressing, these individuals were assumed to have had the disease the entire year of 2002 and therefore to have occurred costs on the COPD population side during the entire year. Thus, in this sense, they do not replace the individuals who leave the population. We tested the significance of this adjustment for mortality in a sensitivity analysis and found the total COPD-related costs 13% higher than in the base case scenario.

Cost-of-illness studies show the burden of specific diseases or as in this case of patients with a certain disease on health care costs or on society as a whole, but do not indicate how and with which clinical effect and evidence these costs are incurred on the system. To include these aspects, other types of analysis should be applied, e.g. cost-effectiveness analyses for assessing and comparing different types of interventions with regard to costs per incremental effect unit. For these reasons, cost-of-illness analyses may point to the severity of a problem, but do not provide the essential information to be used in priority-setting processes.

Conclusion

This paper describes a study on the cost of treating patients with COPD in the Danish health care sector. An initial screening of the National Patient Registry identified some 66,000 individuals with diagnosed COPD. Their resource use in terms of hospital admissions and visits to general practitioners and other specialists in 2002 were collected from the National Patient Registry and the Health Care Reimbursement Scheme Registry and compared with the equivalent resource use of a control group without COPD.

The COPD population accounted for approximately 10% of the 2002 health care costs in Denmark related to the treatment of patients of 40 years or more. The control group signified the morbidity and resource use of a population without COPD with the same age and sex composition as the COPD population. The cost of treating this population was deducted from the COPD gross cost to calculate the net costs that could be attributed to the treatment of COPD and its related diseases. In this comparison, the net cost of treating patients with COPD in Denmark in 2002 amounted to approximately 2 billion DKK (256 million €) (6% of total). Less than one-third of these costs (app. 600 million DKK, (81 million €)) were due to COPD as the primary reason for being admitted to hospital. COPD might occur as a complicating diagnosis, or not at all. The majority of the primary diagnoses (61%) for patients which had once been admitted to hospital for COPD, were other respiratory diseases, cardiovascular diseases including pulmonary heart disease and cancer. The significance of controlling for primary diagnoses which do not have a causal relationship with COPD, e.g. lesions and poisonings, was not great. Only 7% of the COPD attributable costs came from such diagnoses.

Other cost-of-illness studies have only included disease-specific costs and failed to consider the cost of co-morbidity.

Thus, in general, cost-of-illness studies underestimate the real disease impact on health care resources. This study estimated the patient-specific costs of COPD in comparison with non-COPD control and showed the impact of COPD co-morbidity on health care costs. The study design was inspired by two studies from the USA on osteoarthritis. Our conclusions were consistent with their findings: that the cost of treating related diseases should be included in cost-of-illness estimates. However, the lack of patient registers, personal identification codes and access to the data may limit the possibility of conducting studies like the present in other countries. It is possible in managed care organisations in the USA, as they are closed environments data-wise. It is possible on a large scale in Denmark, as Danish registers count the health care resource use of more than 5 million people—the entire Danish population—who are registered with their personal identification code from the date of birth to the day they die. It is expected that a provision will soon be made administratively for linking information between the National Patient Registry and the Register for Medicinal Product Statistics. This will provide another unique possibility for research on diagnosis-specific prescriptions and sale of medicines in Denmark, something which will add a valuable contribution to the estimate of diagnosis-specific resource use.

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