ERJ Express. Published on April 30, 2008 as doi: 10.1183/09031936.00059807

The impact of using different mortality outcomes in COPD patients on risk factors analysis

Annunziata Faustini, Claudia Marino, Daniela D'Ippoliti, Francesco Forastiere, Valeria Belleudi, Carlo A Perucci

Department of Epidemiology,

Rome E Local Heath Unit

Address correspondence about the manuscript to

Dr A Faustini, Department of Epidemiology, LHU RME,

V. S. Costanza n 53,

00198 Rome

Italy

Tel. 0039/06/83060486 e-mail faustini@asplazio.it

Fax simile 0039/06/83060463

RUNNING TITLE : Two measures of 30-day mortality for COPD

ABSTRACT WORD COUNT = 198

TEXT WORD COUNT = 2858

ABSTRACT

Questions of the study: To analyse the role of potential selection processes and their impact when evaluating risk factors for 30-day mortality among patients hospitalized for chronic obstructive pulmonary disease (COPD).

Patients and methods: A cohort of 26,039 patients, 35+ years old, hospitalised with a COPD was enrolled. A 30-day follow-up was carried out using both the cause mortality register (CMR) and the hospital discharge register (HDR). Individual and hospital factors associated with 30-day mortality were studied using both mortality outcomes.

Results: The 30-day mortality rate was 1.21 per 1000 p-days (95%CI=1.14-1.29) using the CMR and 1.06 per 1000 p-days (95%CI=0.98-1.13) using the HDR. Male patients, the most poorly educated, those who reside outside Rome, and those who had more than one hospitalisation in the two previous years were more likely to die after discharge than when hospitalized. The most frequent cause of in-hospital death was respiratory disease, and after-discharge, heart disease. Older age, male gender, comorbidities, previous hospitalizations for respiratory failure, and admission to a ward not appropriate to treat respiratory diseases were the most important predictors of 30-day mortality.

Conclusion: Using in-hospital 30-day mortality gives a significantly different estimate of the role of specific risk factors.

KEY WORDS : 30-day mortality for COPD; mortality follow-up; mortality underestimate; selection impact on outcome studies.

INTRODUCTION

Short-term mortality, i.e. mortality within 30 days after hospital admission, is the most frequently used outcome to evaluate hospital care quality and to study factors associated with death in patients with chronic obstructive pulmonary disease (COPD) [1,2]. The underlying assumptions for this approach are that: 1) short-term mortality is influenced by the quality of treatment the patients received in the hospital [3], 2) a 30-day interval is an adequate amount of time to analyse the association of hospital treatment with short-term mortality, 3) in-hospital 30-day mortality is a valid approximation of total 30-day mortality.

Some criticisms have been emerging on the use of in-hospital mortality as it is only a proxy measure of short-term outcomes and there is a selection of the patients discharged before 30 days. A study [4] reported an 18.4% total 30-day mortality compared with 8.8% in-hospital mortality in patients with acute myocardial infarction (AMI); moreover the hospital performance measures were correlated with the former but not with the latter outcome. Another study [5] showed an in-hospital mortality of 21.2/100000 and a total mortality of 35.4/100000 among injured patients; injured patients who died in hospital also presented different characteristics than all of those who died within 30 days; they were younger, had more severe injuries and fewer pre-existing medical conditions. Finally, the classification of hospital quality based on both in-hospital and total 30-day mortality often differed [6], suggesting the two measures are similar but not equal. In spite of these limitations, in-hospital mortality is still proposed as a hospital quality indicator for AMI, congestive heart failure (CHF), stroke, gastrointestinal haemorrhage, hip fracture and pneumonia [3]. On the other hand, both mortality measures has been recommend in England to construct the 30-day mortality indicator of hospital performance for stroke [7].

Little is known about the impact that a possible selection of discharged patients may have in analysing factors associated with short-term outcomes among COPD patients. To analyse this possible impact, we measured 30-day mortality since hospital admission in a cohort of

COPD patients using both the causal mortality register and the hospital discharge records, and analysed the factors associated with the two mortality measures.

METHODS

Study population

The study population was enrolled from the hospital discharge register (HDR) and defined as 35+ year old residents of the Lazio region of Italy, (about 5 million inhabitants), hospitalised for COPD between 1 January 1998 and 1 November 2000, identified by the primary diagnosis (codes of International Classification of diseases 9th revision (ICD-9) 490.X, 491.X, 492.X, 494.X and 496.X [8]) according to the information reported in the same register. When more than one hospitalization occurred in the study period, the first one was chosen as the index hospitalization. The clinical history of each patient was reconstructed based on hospital diagnoses from the previous two years.

Follow-up and mortality estimates

Mortality rates were followed-up for 30 days after admission using both the regional cause mortality register (CMR) and the HDR by means of an individual record-linkage; deaths reported in the HDR were identified for the index or subsequent hospitalisations. Follow-up began on the first day of the index hospitalisation; when the patient was discharged from another hospital on the same or previous day with a diagnosis of COPD (primary or secondary), follow-up started on the first day of the previous hospitalisation. Patients not listed in the CMR or in the HDR were assumed to be alive at the end of the study period.

Vital status from each register was validated (for residents of Rome) through information from the municipality register. The characteristics and underlying causes of death of patients who died in hospital and those who died after discharge were compared. Mortality rates were calculated as the number of deaths within 30 days after admission reported in each register over 1000 person-days; 95% confidence intervals (CI) were calculated according to a

binomial distribution.

Factors associated with 30-days mortality and data analysis

Age (ten year groups), gender, place of residence (Rome versus residence anywhere else in the region) and education (years) were analysed. Information on smoking habits and occupation were not available.

The admission ward was selected as an indicator of care quality [3]. The hospital ward was categorised as appropriate for COPD treatment (pneumology and intensive care units (ICU)), acceptable (general medicine, geriatrics, casualty ward), unsatisfactory (all others).

To account for the severity of patients' conditions at the time of hospitalization, information about comorbidities was obtained from the hospital records of the previous two years for lung cancer and pneumoconiosis (ICD-9 codes = 162, 505-506) [9], chronic heart failure (ICD-9 codes = 428) [1], bronco-pneumonia (ICD-9 codes = 480-486) [10,11], pulmonary embolism (ICD-9 codes = 415.1) [12], respiratory failure (ICD-9 codes = 518.8, 518.5, 786.0), kidney failure (ICD-9 codes = 585) [13], all cancers apart from lung cancer (ICD-9 codes = 585, 140-239). Arrhythmias were added as a possible complication of beta-agonists in COPD treatment [11]. The conditions that we tested that are associated with risk of death in COPD patients, such as vascular and heart disease other than AMI and heart failure (ICD-9 codes 390-459, excluding 410, 415 and 428), central nervous system diseases (ICD-9 codes 320-349), traumas (ICD-9 codes 800-829) and poisonings (ICD-9 codes 960-979) were included in the analysis. The methodological indications of Charlson [14], as modified by Deyo [15], were followed in the analysis.

We used the number of comorbidities, the number of hospitalizations that occurred in the previous two years and those with a diagnosis of respiratory failure, as quantitative indicators of patient condition severity. These indicators were included in the multivariable analysis one at time due to the high collinearity between them.

The count of person-days of observation started the first day of hospitalization and ended

with death or on the 30th day. Survival analysis was carried-out. The follow-up time (days) was divided into four intervals; the grouping was the result of a segmental regression analysis [16] of the relationship between daily mortality and follow-up time that identified the lowest mortality level on day 7. Poisson regression analysis was conducted to estimate relative risk of dying (RR) and 95% confidence intervals (95%CI) in univariable as well as in multivariable analysis, since mortality rates differed in the follow-up intervals. STATA software (version 8) was used for the statistical analysis.

RESULTS

30-day mortality.

Among 26,039 patients 35 + years old who were hospitalised with a COPD in the period 1998-2000, 925 deaths (3.6%; 95%CI = 3.3%-3.8%) occurred within 30 days after admission according to the CMR; the mortality rate was 1.21 per 1000 p-days (95%CI = 1.14-1.29). The follow-up carried out with the HDR detected 812 deaths (3.1%; 95%CI = 2.9%-3.3%); the mortality rate was 1.06 per 1000 p-days (95%CI = 0.98-1.13). Both total and in-hospital mortality showed a similar decreasing trend in the follow-up period, but rates decreased more rapidly in the HDR follow-up (Figure 1). Sixty-two in-hospital deaths were not listed in the CMR, and 175 were deaths not reported in the HDR. Only 17% of patients were hospitalized more than once and 0.3% % of them died.

Information on vital status was validated for the 11,433 patients confirmed residents of Rome. Vital status as reported in the CMR had a 93.5% sensitivity and a 99.97% specificity; 38 patients who died according to the municipal register were not reported in the CMR, while 3 patients who were listed as dead in the CMR were still alive 30 days after admission. Vital status from the HDR had a 72.8% sensitivity and a 99.99% specificity.

Factors associated with 30-day mortality

When factors associated with total 30-day mortality (n.925) were analysed (Table 1), age greater than 64 years, male gender, residence in Rome, being admitted to a ward other than

pneumology or ICU, having at least one comorbidity or having been hospitalized at least twice in the previous two years were all associated with increased mortality. The two quantitative indicators of patient severity predicted an increased risk of death proportional to the number of comorbidities and previous hospitalisations. (Table 1). The most frequent comorbidities reported in previous hospitalisations were chronic heart failure (7%), respiratory failure (9%), vascular and heart diseases other than AMI and chronic heart failure (27%); but lung cancer (OR=2.17; 95%CI = 1.25-3.75), CNS diseases (OR=2.06; 95%CI = 1.55-2.74) and renal failure (OR=1.98; 95%CI = 1.29-3.04) were the strongest predictors of short-term mortality.

The multivariable analysis confirmed the results. However, the strength of the association was higher for gender and previous hospitalisation for respiratory failure but weaker for age and comorbidities (Table 2).

The factors associated with in-hospital mortality were very similar to those observed for total short-term mortality, but a few differences were evident in terms of effect estimates for age, gender, education, residence and previous hospitalisations. A statistically significant association was not identified for gender, while the role of comorbidities became much more important in patients with more than two comorbidities and the risk of dying for residents in Rome increased. The mortality rate was the highest for the most poorly educated patients in total short-term mortality analysis and was the lowest based on HDR data. (Tables 1-2).

Characteristics of patients who died

Table 3 shows the characteristics of the 750 patients who died in hospital and the 125 who died after hospital discharge; we did not include in the comparison the sixty-eight patients reported as dead only by HDR. Male patients, those who reside outside Rome, those with the lowest education and those who had more than one hospitalization in the previous two years were more likely to die after discharge than when hospitalised. On the contrary, patients resident in Rome, those well educated, and those who had been not hospitalised in

the previous two years were more likely to die in hospital than after discharge. No differences were observed for age, admission ward and comorbidities (Table 3).

A few differences were found in the underlying causes of death for patients who died when hospitalized and those who died after discharge (Table 4). COPD and all respiratory diseases were the most frequent causes of deaths for the former group of patients, while the most frequent causes of deaths were heart diseases, cancer and other vascular diseases for the latter group. Cerebro-vascular diseases followed as the most frequent cause of death in both groups.

DISCUSSION

In-hospital 30-day mortality (3.1%) observed in this study is consistent with estimates reported in the literature for hospitalised COPD patients; Holguin and coll. reported 5.9% mortality [17] and Patil and coll. observed 2.5% of deaths among patients with exacerbated COPD [18]; higher rates (8%) were reported for acute exacerbations of COPD [2] and in patients with respiratory failure admitted to intensive care units (36.6%) [19]. However, in-hospital mortality is lower than total mortality (3.8%) and underestimates true mortality, an underestimate that increases over the follow-up time.

The differences observed between patients who died in hospital and those who died after discharge were clinically justified in most cases. COPD patients who had suffered from respiratory failure in the last two years were more likely to die in-hospital during the first week [18]. The higher proportion of patients discharged in the second week of hospitalisation who died (37.1% vs. 28.3% who died in hospital during the second week) could be explained in light of other observations. The mortality rate for patients discharged after the first week was however lower than for patients retained in hospital more than one week; this suggests they completed the treatment, according to the expected duration of COPD exacerbation from 7 to 10 days on average. Cardiovascular diseases were the most frequent cause of death among discharged patients, and patients who died at home were more likely to have

comorbidities and to have been hospitalized in the previous two years than those who died when hospitalized, apart from respiratory diseases. It could be hypothesized that the patients who were discharged in the second week of hospitalisation were more likely to die from heart disease because cardiac complications occurred in these patients after discharge, though it cannot be excluded that cardiovascular problems may not have been adequately recognised during hospitalization.

Other factors influenced a selective discharge of the patients. Male patients died more frequently at home, as did poorly educated patients. It is difficult to hypothesise the reason in both cases. Also, the patients who reside in Rome were more likely to die in the hospital than after discharge; one hypothesis could be that in Rome comorbidities are more likely to be detected causing the patients to be retained longer in hospital, since we observed in Rome a higher proportions of patients reported with comorbidities (54% vs. 44% outside Rome) and a longer length of hospital stay (12.0% vs.10.3% outside Rome).

Although all of these results need further confirmation, we can conclude that in our data, male patients, those with the least education, those who reside outside Rome, those discharged in the second week and those who were more seriously ill with conditions other than respiratory diseases were more likely to be discharged before death and therefore these deaths would obviously not be reported in the HDR. Below we discuss the impact this selection had on the associations studied, when these characteristics are included among the risk factors.

Factors associated with short-term mortality

Among the factors we found to be associated with total 30-day mortality in COPD patients, being over 64 years of age and male have been reported already [20] as well as the presence of concomitant diseases [9-13]. The increasing risk proportional to the number of comorbidities and to the number of previous hospitalizations has been less frequently reported; however the exposure-effect relationship we observed here indicates with some

confidence that these severity indicators are true risk factors for 30-day mortality. The higher risk for residents of Rome, a large city (2.5 millions of inhabitants) with significant air pollution problems, suggests a role of air pollution in increasing the risk of short-term mortality in COPD patients, as already reported [21]. On the other hand, the accuracy of the mortality data may be different in Rome with respect to other areas.

As relates to the indicators of care quality, the higher risk of death associated with wards other than pneumology, ICU and general medicine, in the absence of data about hospital organisation, allows only to hypothesise that the therapeutic protocols or the availability of adequate drugs and equipment explain these differences. Comparing mortality between patients who died in hospital with those who died at home in different periods of the follow-up, the most relevant results are the higher mortality rate observed for patients who were hospitalised only for one week regardless of the place of death, and the higher proportion of patients who died at home than in hospital in the second week of the follow-up. These results suggest a different risk profile for these two groups of patients, those who died in-hospital in the first week possibly were too seriously ill to benefit from hospital treatment while those who died at home in the second week of follow-up possibly incurred treatment side effects or complications not recognised during admission.

Other studies have pointed to different factors influencing mortality, including the volume of procedures [22]; we did not conduct this analysis because there is not enough evidence for an association between the number of patients and the outcomes for COPD [23].

The impact of using different short-term mortality measures on risk factor analysis.

The factors associated with in-hospital mortality were very similar to those observed for total short-term mortality, with a few important differences.

A selection of patients discharged before 30 days is the most probable explanation of most differences. The consequences of this selection are missing important associations like the increased risk for males, exaggerating the risk for residents of Rome and lowering the

risk for having comorbidities and for having been hospitalized in the previous two years for conditions other than respiratory diseases.

Limitations of the study

The lack of information on other determinants of mortality in COPD patients such as occupational exposure [24] and smoking [25], could have affected the accuracy of our assessment. The lack of information on the dates complications began and ventilation enabled us to analyze the role of these factors as possible risk factors in a prospective approach for the later mortality we observed. Another problem is related to the method used to assess comorbidities. Although the method is widely employed, evaluating patient history only for two previous years may have misclassified patients with chronic underlying diseases.

In conclusion, in-hospital 30-day mortality is an underestimate of total 30-day mortality. It includes only 86.5% of all deaths and causes a selection of patients for gender, education level, residence and underlying condition severity. We found that admission to wards not appropriate to treat respiratory diseases is the most important factor related to care management that is associated with 30-day mortality for COPD patients. Older age, male gender and condition severity are the strongest risk factors among the individual characteristics. We believe that it is vital to check for possible selection of discharged patients when in-hospital 30-day mortality is used as the preferred outcome in evaluating the quality of hospital care.

ACKNOWLEDGEMENTS

We thank Margaret Becker for the English revision and Sarah Pennisi for her help with the figure.

REFERENCES

[1] Almagro P, Calbo E, Achoa de Echaguen A et al. Mortality after hospitalization for COPD. Chest 2002; 121: 1441-1448.

[2] Groenewegen KH, Schols AM, Wouters EF. Mortality and mortality-related factors after hospitalization for acute exacerbation of COPD. Chest 2003; 124: 459-467.

[3] AHRQ Guide to Inpatient Quality Indicators: quality of care in hospitals – volume, mortality and utilization; Agency for Healthcare Research and Quality 2004; Pub no. 02-R0204.

[4] Bradley EH, Herrin J, Elbel B, McNamara RL, Magid DJ, Nallamothu BK et al. Hospital quality or acute myocardial infarction. Correlation among process measures and relationship with short-term mortality. JAMA 2006; 296: 72-78.

[5] Mullins RJ, Mann NC, Hedges JR, Worrall W, Helfand M, Zechnich AD et al. Adequacy of hospital discharge status as a measure of outcome among injured patients. JAMA 1998; 279: 1727-1731.

[6] Rosenthal GE, Baker DW, Norris DG, Way LE, Harper DL, Snow RJ. Relationship between in-hospital and 30-day standardized mortality: implications from profiling hospitals. Health Serv Res 2000; 34: 1449-1468.

[7] NHS Performance Indicators 6, A, Clinical indicator 3B. Deaths within 30 days of emergency admission to hospital following a stroke. Available on the website: http://www.performance.doh.gov.uk/nhsperformanceindicators/2002/ha_intro.html

[8] European Commission for public health. European Community Health Indicators. Indicators for monitoring COPD in the EU. Available on the website: http://europa.eu.it.int .

[9] Mannino DM, Brown C, Giovino GA. Obstructive lung disease deaths in the United States from 1979 through 1993. Am J Respir Crit Care Med 1997; 156: 814-818.

[10] Hansell AL, Walk JA, Soriano JB. What do chronic obstructive pulmonary disease patients die from? A multiple cause coding analysis. Eur Respir J 2003; 22:809-14.

[11] Salpeter SR, Ormiston TM, Salpeter EE. Cardiovascular effects of β-agonists in patients with asthma and COPD. Chest 2004; 125: 2309-2321.

[12] Zielinski J , McNee W, Wedzicha J et al. Causes of death in patients with COPD and chronic respiratory failure. Monaldi Arch Chest Dis 1997; 52: 43-47.

[13] Antonelli Incalzi R, Fuso L, De Rosa M et al. Co-morbidity contributes to predict mortality of patients with chronic obstructive pulmonary disease. Eur Respir J 1997; 10: 2794-2800.

[14] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chron Dis 1987; 40: 373-383.

[15] Deyo R, Cherkin DC, Ciol MA. Adapting a clinical Comorbidity index for use with ICD-9-CM administrative databases. J Clin Epidemiol 1992; 45: 613-619.

[16] Muggeo VMR. Estimating regression models with unknown break-points. Stat Med 2003; 22:3055-3071

[17] Holguin F, Folk E, Redd SC, Mannino DM. Comorbidity and mortality in COPD-related hospitalizations in the United States, 1979 to 2001. Chest 2005; 128: 2005-2011.

[18] Patil SP, Krishnan JA, Lechtzin N, Diette GB. In-hospital mortality following acute exacerbations of chronic obstructive pulmonary disease. Arch Intern Med 2003; 163: 1180-1186.

[19] Khilnani GC, Banga A, Sharma SK. Predictors of mortality of patients with acute respiratory failure secondary to chronic obstructive pulmonary disease admitted to an intensive care unit. A one year study. BMC Pulmonary Medicine 2004; 4: 12.

[20] Mannino DM, Homa DM, Akimbami MD, Ford ES, Redd SC. Chronic obstructive pulmonary disease surveillance, United States, 1971-2000. MMWR Surveill Summary 2002; 51: 1-16.

[21] Sunyer J. Urban air pollution and chronic obstructive pulmonary disease: a review. Eur

Respir J 2001; 17:1024-1033.

[22] Halm EA, Lee C, Chassin MR Is volume related to volume in health care ? A systematic review and methodological critique of the literature. Ann Intern Med 2002;137: 511-520.

[23] Burns LR Wholey DR. The effects of patients, hospital and physician characteristics on length of stay and mortality. Med Care 1991; 29: 251-271.

[24] Balmes JR. Occupational contribution to the burden of Chronic Obstructive Pulmonary Disease. J Occup Environ Med 2005; 47:154-160.

[25] Spurtzem JR, Rennard SI. Pathogenesis of COPD. Semin Respir Crit Care Med 2005; 26:142-153.

Table 1. Risk of dying within 30 days of admission in COPD patients according to different follow-up sources. Lazio, 1998 - 2000.

		Mortality register					Hospital discharge register				
	p-days	cases n.925	rate/ 1000 p-days	crude RR	IC 95%		cases n. 812	rate/ 1000 p-days	crude RR	IC 95%	
	770000										
age (years)											
35 - 54	50000	6	0.12	1			4	0.08	1		
55 - 64	110000	19	0.17	1.41	0.56	3.54	16	0.14	1.79	0.6	5.35
65 - 74	250000	167	0.67	5.60	2.48	12.65	149	0.60	7.50	2.78	20.25
75 - 84	250000	377	1.52	12.62	5.63	28.27	345	1.39	17.33	6.47	46.43
85+	110000	356	3.35	27.88	12.44	62.48	298	2.79	34.84	12.99	93.43
gender											
female	325000	366	1.13	1			343	0.11	1		
male	445000	559	1.13	1.13	0.99	1.29	469	0.11	1.01	0.88	1.16
place of residence											
outside Rome	430000	435	1.01	1			372	0.86	1		
Rome	330000	490	1.46	1.45	1.27	1.65	440	1.31	1.52	1.32	1.75
education (years)											
>8	62000	77	1.25	1			77	1.25	1		
5 - 8	540000	628	1.17	0.93	0.74	1.18	557	1.03	0.83	0.65	1.05
<5	95000	121	1.28	1.02	0.77	1.36	94	0.99	0.79	0.59	1.07
mi	73000	99									
admission ward*		925									
appropriate	170000	152	0.90	1			123	0.72	1		
acceptable	530000	673	1.27	1.43	1.20	1.70	597	1.13	1.57	1.29	1.90
not appropriate	65000	100	1.54	1.73	1.34	2.22	92	1.41	1.97	1.50	2.58
follow-up time (days)											
0 - 6	160000	315	2.03	1			318	2.05	1		
7 - 13	180000	228	1.27	0.63	0.53	0.74	210	1.17	0.57	0.48	0.68
14 - 20	180000	179	1.01	0.50	0.41	0.60	145	0.81	0.40	0.33	0.48
21 -30	250000	203	0.80	0.40	0.33	0.47	139	0.55	0.26	0.22	0.33
number of comorbidities†											
none	490000	468	1.00	1			420	0.85	1		
1	140000	170	1.26	1.32	1.11	1.57	152	1.12	1.32	1.09	1.58
2	100000	183	1.84	1.93	1.62	2.29	153	1.53	1.79	1.49	2.16
3+	39000	104	2.68	2.81	2.27	3.47	87	2.23	2.61	2.07	3.29
previous hospitalisation in the past two years											
0	400000	441	1.10	1			408	1.01	1		
1	185000	220	1.23	1.12	0.95	1.32	188	1.05	1.03	0.87	1.23
2	185000	264	1.44	1.32	1.13	1.54	216	1.18	1.16	0.99	1.37
previous hospitalisation in the past two years with respiratory failure											
0	730000	854	1.17	1			752	1.03	1		
1	29000	42	1.44	1.23	0.9	1.67	35	1.20	1.16	0.83	1.63
2	8500	29	3.39	2.89	2.00	4.18	25	2.90	2.81	1.89	4.19

RR = rates ratios. mi = missing information.

* appropriate = pneumology and intensive care unit, acceptable = general medicine, geriatrics, causality ward; †respiratory failure, lung cancer, pneumoconiosis, other cancer, heart failure, arrhythmias, other heart and vascular diseases excluding AMI, chronic kidney failure, central nervous system diseases, traumas and poisonings during previous hospitalization.

Table 2. Association between various factors and 30-day mortality in COPD patients according to different follow-up sources. Lazio, 1998 - 2000.

	total 30-day mortality			in-hospital 30-day mortality		
	adjusted RRs	IC 95%		adjusted RRs	IC 95%	
age (years)						
35 - 54	1			1		
55 - 64	1.38	0.55	3.46	1.77	0.59	5.30
65 - 74	5.22	2.31	11.79	7.11	2.63	19.20
75 - 84	11.53	5.14	25.86	15.97	5.96	42.83
85+	25.48	11.36	57.18	31.51	11.74	84.61
gender						
female	1			1		
male	1.34	1.17	1.53	1.19	1.03	1.37
place of residence						
outside Rome	1			1		
Rome	1.50	1.31	1.71	1.58	1.37	1.81
admission ward						
appropriate	1			1		
acceptable	1.16	0.97	1.38	1.29	1.06	1.57
not appropriate	1.41	1.09	1.82	1.63	1.24	2.13
follow-up time (days)						
0 - 6	1			1		
7 - 13	0.63	0.53	0.75	0.58	0.48	0.69
14 - 20	0.50	0.42	0.61	0.40	0.33	0.49
21 -30	0.41	0.34	0.48	0.27	0.22	0.33
number of comorbidities*						
none	1			1		
1	1.21	1.02	1.44	1.21	1.00	1.45
2	1.55	1.3	1.83	1.44	1.20	1.73
3+	2.03	1.64	2.51	1.89	1.50	2.38
previous hospitalisation in the past two years*						
0	1			1		
1	1.04	0.89	1.23	0.97	0.81	1.15
2	1.21	1.04	1.41	1.07	0.91	1.26
previous hospitalisation in the past two years with respiratory failure*						
0	1			1		
1	1.30	0.96	1.78	1.24	0.88	1.74
2	3.58	2.47	5.20	3.44	2.30	5.14

RR = rates ratios, adjusted for all factors in the table.
mi = missing information.
* these variables were estimated in different models due to the collinearity. with this last variable. The results for all other factors come from the model that includes the number of comorbidities.

Table 3. Comparison of the characteristics of COPD patients who died in hospital or after discharge within 30-days of admission. Lazio, 1998 – 2000.

Characteristics	Subjects deceased		p-value†
	in hospital (n.= 750)	after discharge (n.=125)	
	100	100	
age (years)			
35 - 54	0.5	1.1	0.4
55 - 64	1.7	3.4	0.2
65 - 74	18.0	18.3	0.9
75 - 84	42.0	35.4	0.1
85+	37.7	41.7	0.3
gender			
male	58.3	69.7	**0.005**
place of residence			
Rome	54.5	46.3	**0.05**
education (years)			
> 8	8.9	5.7	0.2
5 - 8	68.7	64.6	0.3
< 5	11.6	19.3	**0.006**
admission ward			
appropriate	15.5	20.6	0.1
acceptable	73.5	69.7	0.3
not appropriate	11.1	9.7	0.6
number of comorbidities			
none	51.1	48.6	0.6
1	10.2	14.9	0.2
2	18.9	23.4	0.2
3+	10.8	13.4	0.4
2-year previous hospitalisation			
none	49.5	40.0	**0.02**
1	23.6	24.6	0.8
2	26.9	35.4	**0.03**
2-year previous hosp with respiratory failure			
none	92.3	92.6	0.9
1	4.5	4.6	1.0
2	3.2	2.9	0.80

*sixty-two patients who died in hospital and were not reported in the CM register are not included here.

†p-value from a test of difference in proportions.

Table 4. Underlying causes of deaths in COPD patients who died in hospital or after discharge within 30-days of admission. Lazio, 1998 – 2000.

	in-hospital deaths		after discharge deaths		
death cause	**n**	**%**	**n**	**%**	**p-value†**
All	**750***	***100***	**175**	**100**	
Respiratory diseases	**438**	***58.40***	**56**	**32.00**	**0.001**
COPD	387	*51.60*	48	27.43	0.001
respiratory failure	9	*1.20*	0		
bronco-pneumonia	9	*1.20*	3	1.71	0.6
other respiratory	33	*4.40*	5	2.86	0.40
Cancer	**35**	***4.67***	**18**	**10.29**	**0.007**
lung	1	*0.13*	5	2.86	0.001
others	34	*4.53*	13	7.43	0.11
Diabetes	**12**	***1.60***	**6**	**3.43**	**0.1**
CNS diseases	**8**	***1.07***	**1**	**0.57**	**0.5**
Heart diseases	**136**	***18.13***	**60**	**34.29**	**0.001**
Cerebrovascular diseases§	**34**	***4.53***	**11**	**6.29**	**0.3**
Other vascular diseases#	**14**	***1.87***	**9**	**5.14**	**0.01**
Digestive system diseases	**24**	***3.20***	**6**	**3.43**	**0.8**
Trauma/poisonings	**13**	***1.73***	**1**	**0.57**	**0.3**
Others**	**16**	***2.13***	**4**	**2.29**	**0.9**
Not well defined	**17**	***2.27***	**2**	**1.14**	**0.3**
Not reported	**3**	***0.40***	**1**	**0.57**	**0.8**

* sixty-two patients who died in hospital and were not reported in the CM register are not included here.

†p-value from a test of difference in proportions.

§ includes ictus and atherosclerosis

includes pulmonary embolism and cor pulmonale, acute or chronic

**includes viral hepatitis, sepsis, meningitis, metabolic diseases other than diabetes, anaemia, psychiatric diseases, urinary system diseases, decubitus ulcers.

Figure 1. 30-day mortality by follow-up time and follow-up source.

X – axis title = follow-up time (days)
Y – axis title = cumulative mortality (deaths/1000 patients)

Legend black line = follow-up by cause mortality register
grey line = follow-up by hospital discharge register