



Earlier palliative home care is associated with patient-centred medical resource utilisation and lower costs in the last 30 days before death in COPD: a population-level decedent cohort study

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Palliative home care is associated with more patient-centred care and reduced costs in the final month of life for people with COPD <http://bit.ly/2Pr2U1i>

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ABSTRACT COPD patients often use many medical resources, such as hospital admissions and medical imaging, inappropriately close to death. Palliative home care (PHC) could beneficially affect this. The aim was to study the effect of use and timing of PHC on medical resource use and costs in the last 30 days before death (DBD) for COPD.

We performed a retrospective study of all Belgian decedents in 2010–2015 with COPD and a primary cause of death being COPD or cardiovascular diseases. Odds ratios for medical resources were calculated between using and four PHC timing categories (>360, 360–181, 180–91 and 90–31 DBD) *versus* not using. Confounders were socio-demographic, care intensity and disease severity variables.

Of the 58 527 decedents with COPD, 644 (1.1%) patients received PHC earlier than 30 DBD. Using PHC (*versus* not using) decreased the odds ratio for hospitalisation (0.35), intensive care unit admission (0.16), specialist contacts (0.58), invasive ventilation (0.13), medical imaging including chest radiograph (0.34), sedatives (0.48) and hospital death (0.14). It increased the odds ratio for home care (3.27), general practitioner contact (4.65), palliative care unit admission (2.61), noninvasive ventilation (2.65), gastric tube (2.15), oxygen (2.22) and opioids (4.04) ($p < 0.001$). Mean total healthcare costs were €1569 lower for using PHC. All PHC timing categories showed a benefit in medical resource use and costs. However, we observed the largest benefit in the category PHC 90–31 DBD.

Health policy and services should focus on increasing PHC access, while research should further explore early PHC initiation for COPD.

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Introduction

COPD is one of the leading causes of death, with global prevalence estimated to further rise in the near future [1]. There are a number of studies signalling medical resource use that might be inappropriate close to death for COPD, such as diagnostic testing, frequent acute hospitalisations in the last 30 days before death [2] and life-prolonging care instead of comfort care in the last week before an expected death [3]. Earlier research has shown that end-stage COPD patients prefer to be cared for at home [4] and suffer from symptoms such as low mood, breathlessness, sleeping problems, anxiety [5]. These symptoms reflect their palliative care needs [5], which can be supported by palliative home care (PHC) if the patient's situation allows it.

The World Health Organization [6] advocates a timely initiation of PHC. This type of support might better align medical resource use with patient care preferences, as the patient-centred approach takes into account individual care needs and wishes in a timely manner [7]. A 2016 US-based study exploring the effects of PHC on healthcare use for COPD patients reported less hospital use and lower costs [8]. Other studies showed that PHC reduces hospital death [9, 10], improves patients' quality of life [11–13] and decreases symptom burden [14]. However, despite these promising study results and pleas from health organisations, only a small minority of COPD patients receive PHC [3, 5, 15], and, if so, predominantly very close to death [2].

A number of studies have reported on the link between palliative care and lower medical resource use for COPD such as hospitalisations [8, 16]. However, population-level evidence is lacking, although it could give us more insight into the provision of appropriate end-of-life care in COPD. Here, we report population-wide retrospective study results describing the effect of use and timing of PHC, provided by multidisciplinary teams in Belgium (see table 1 for explanation of PHC and comparison with hospice care), on medical resource use and costs in COPD. Two research questions are addressed: 1) How do medical resource use and costs in the last 30 days before death differ between COPD patients using PHC *versus* those who did not? 2) How do medical resource use and costs in the last 30 days before death differ between COPD patients using PHC for the first time >360, 360–181, 180–91 and 90–31 days before death *versus* those who did not?

Methods

Study design and setting

Following strobe-guidelines (see checklist in Appendix 4), we performed a retrospective full population analysis of people dying with COPD between January 1, 2010, and December 31, 2015, in Belgium.

Data sources

A total of seven administrative and health claims databases were linked to create one common full population database [18]. Data consisted of health claims data retrieved from the InterMutualistic Agency (IMA) and socio-demographic, socioeconomic and death certificate data from Statistics Belgium. In short, the IMA

TABLE 1 Palliative home care (PHC) teams in Belgium

Organisation

Belgium has region-bound PHC, which is a separate secondary care service. PHC is somewhat similar to hospice care teams in the USA, although the latter takes over care whereas PHC teams in Belgium support the regular care services in providing palliative care. They are a multidisciplinary team consisting of a PHC physician, PHC nurses and a psychologist. In total, 27 networks (of which, 15 are in Flanders) are operating in Belgium. The patient's general practitioner (GP), depending on the patient's individual context, requests PHC. This is mostly in consultation with the patient, informal carers, involved community nurses, palliative care nurses in the hospital or specialists. The main focus of PHC teams are home visits by the PHC nurses to support the patient and informal carers for psychological, social, physical and spiritual needs (holistic approach). PHC nurses also collaborate with the involved GP if necessary. The PHC physician and the PHC psychologist are involved in weekly meetings and in psychological support for patients and informal carers. Although variation exists, most PHC teams do not use standardised documents or scales to assess the symptoms and needs of the patients. Rather, they report in a general electronic patient file, which they do not systematically share with other health professionals. Contact with the latter is mainly by telephone.

Palliative status

Before referring patients to PHC, the responsible GP can request an optional "palliative status" which is a formal statute, unique to Belgium, tied to healthcare reimbursement of costs related to the palliative phase. The reimbursement system for PHC in Flanders is by law restricted to patients with 3 months life expectancy, with the possibility of making a second claim [17]. This changed to 6 months in November 2018. If a GP does not request a palliative status, patients can still receive PHC. The capitated hospice benefit in the USA is a similar statute allowing for reimbursement of medical (home) care costs towards the end of life if the patient meets specific criteria, such as a 6-month life expectancy.

database contains all reimbursed healthcare consumption and pharmaceutical dispensing data for all Belgian citizens [19]. Statistics Belgium manages the national demographic database, derived from the population registry [20] and Census 2011 data [21]. Finally, we linked a fiscal database (*i.e.* net taxable household income), also managed by Statistics Belgium, to allow additional socio-economic insights. A common unique identifier (*i.e.* social security number) made deterministic linking possible. A detailed description of the databases, the data linkage process, quality and content are described in detail elsewhere [18].

Study population

For the study population, we first selected all those who died with COPD. Then we extracted two groups from that selection based on their underlying cause of death noted on the death certificate in Belgium between 2010 and 2015: 1) those who died of COPD (International Classification of Diseases, 10th Revision, ICD10-codes: J41–44) and 2) those who died of cardiovascular diseases (ICD10-code I00–I99). We only included these primary causes of death because previous population-based research in Belgium found similar referral to PHC for both [22]. Cardiovascular diseases are also the second most common cause of death and comorbidity in COPD, after COPD itself [23]. We excluded those dying with COPD and of lung cancer, because of the strong association between PHC and cancer which could cause biased results [3].

Variables and measures

Outcomes: medical resource use in the last 30 days before death

First, medical healthcare resources were selected using insights from similar studies [2, 22, 24]. A multidisciplinary group of researchers (a pulmonologist, sociologists and general practitioners) decided upon the final selection which can be clustered in four groups. 1) Hospital and primary care interventions and admissions: hospitalisation, emergency room, intensive care unit, palliative care unit, one-day care, home care and contacts with general practitioner (GP), specialist and physiotherapist. 2) Medical procedures typical for COPD patients and end-of-life care: invasive ventilation, non-invasive ventilation, urinary tract catheter, cardiopulmonary resuscitation, medical imaging, chest radiograph and spirometry. 3) Medication for COPD and comfort: oxygen, COPD medication, opioids, sedatives, morphine. 4) Place of death: in hospital, at home or in a nursing home.

The IMA healthcare and pharmaceutical databases coded healthcare activities and medication data respectively as nomenclature codes for reimbursement purposes and Anatomical Therapeutic Classification (ATC) codes. In order to answer our research questions, we interpreted and aggregated specific nomenclature numbers into meaningful care interventions/admissions, procedures, medication and place of death categories.

Outcomes: medical costs in the last 30 days before death

Based on all specific healthcare consumption data, we calculated total healthcare costs from a third party and patient co-payment perspective, consisting of total inpatient cost and total outpatient cost for both groups. Inpatient costs included all specific intervention and medication costs in the hospital. Outpatient costs included all specific intervention and medication costs outside the hospital. For a detailed description, please refer to the supplementary material. Based on the exact dates of delivery, we calculated the total inpatient and outpatient costs for the last 30 days before death by specific timing category of receiving PHC. We actualised all costs to 2017 values based on the unit cost of all defined resources in that year.

Exposure: PHC use and timing

We defined the exposure, using PHC, as receiving a minimum of one home visit from a multidisciplinary PHC team in the last two years before death. We operationalised this with a categorical variable of timing in days before death, which we defined for analysis purposes based upon the dates related to a code for the first reimbursement of costs related to PHC. This did not give us insights in the frequency of PHC visits, as we could not derive this from the data.

To compare medical resource use and costs between those who did receive PHC at least once in the two years before death and those who did not, the selected data had to meet two conditions. Firstly, the exposure variable (PHC) had to occur before the outcome variable (medical resource use in the last 30 days before death) to meet the criterion of temporality of our design. Therefore, we selected only those who used PHC at least one month before death, while analysing medical resource use and costs in the last 30 days before death. For the outcome place of death, however, we could also include those who used PHC in the last month of life, as this posed no problem for the temporality criterion.

Second, we minimised confounding factors by controlling for as many covariates as possible that could potentially affect the results. We identified relevant and measurable covariates from a comprehensive set of clinically significant possible risk factors used in similar research [2, 24, 25]: 1) socio-economic covariates: age, sex, household type, educational level attained, taxable income, Charlson comorbidity index, year of death, urbanisation level of the municipality of residence; 2) medical resource use related to care intensity and disease severity covariates between two years and 30 days before death: number of home care visits from a community nurse with a palliative character in the last 360 days before death (this is not the same as PHC visits), mean length of stay after admission to an intensive care unit, number of hospital, one-day care and emergency room admissions, number of chest radiographs and invasive ventilations and number of contacts with a GP, physiotherapist and specialist. We excluded confounders if there was a conceptual overlap with the particular outcome variable to avoid multicollinearity (Appendix 1).

Besides describing the effect of PHC use on specific resource use and costs, we also analysed the timing of first PHC use. For this, we distinguished four timing categories: 1) having received PHC for the first time >360, 2) between 360 and 181, 3) between 180 and 91 and 4) between 90 and 31 days before death. This distinction was based on 1) the eligibility criteria for reimbursement of PHC-related costs in Belgium as determined by law in 2010–2015, which stated a maximum life expectancy of 90 days; 2) for analysis purposes: to calculate odds ratios of medical resource use between each timing category and those who did not use PHC.

Finally, participant characteristics included sex, age at death, urbanisation level of the municipality of residence, educational level attained, household type, Charlson comorbidity index and taxable income.

Statistical analysis

We conducted multivariable analysis controlling for many covariates, using SAS version 9.3. The aim here was to approximate the advantages of randomisation and the prospective setting of a trial, as the latter would be impossible to execute for ethical and practical reasons. To investigate potential differences, we compared patient characteristics, resource use and costs for PHC use *versus* not using, by performing chi-squared tests for categorical variables and Wilcoxon rank sum tests for continuous variables. Resource data were then analysed using logistic regression (odds ratios) for all variables, with using PHC *versus* not using PHC (reference category) as independent variables and controlling simultaneously for various covariates (see subsection on measures). We set the significance level at $p \leq 0.05$. We analysed timing of PHC by offsetting each timing category against no PHC.

In accordance with Belgian law, approvals for access to the various databases and the database integrating all databases were obtained from two separate national committees for privacy protection: the Sectoral Committee of Social Security and Health, Section Health and the Statistical Supervisory Committee. Both are subcommittees of the Belgian Commission for the Protection of Privacy. Additionally, the ethics committee of the Ghent University Hospital granted its approval (B670201422382).

Results

Between 2010 and 2015, 642 901 people died in Belgium. Of those, 634 445 (98.7%) were insured by one of the eight health insurance funds and therefore had data on reimbursement of healthcare and medication data.

Population characteristics

Of all 634 445 insured people who died in 2010–2015, 58 527 (9.1%) died with COPD and died of COPD or of cardiovascular diseases. Of those 58 527, 1751 (3.0%) used PHC, of which 644 earlier than the last 30 days before death (figure 1). The majority of these 644 were men (59.8%), 75–84 (38.5%) years old, received primary education only (30.3%), lived with their partner (49.2%) and died of COPD (57.6% *versus* 41.4% for not using PHC; $p < 0.001$). Both groups had equal numbers of comorbidities, urbanisation and income levels (tables 2 and 3). Appendix 1 shows the population characteristics for the PHC timing categories.

Medical resource use

The bivariate results of medical resource use (table 4) show that for care interventions and admissions, those who used PHC *versus* those who did not were hospitalised less often (24.7% *versus* 47.9%) and for shorter periods (2.6 *versus* 5.3 days). They were less often admitted to the intensive care unit (3.7% *versus* 19.2%), one-day care (0.9% *versus* 2.1%), and seen by specialists (9.2% *versus* 16.9%). They used more often palliative care unit care (7.6% *versus* 1.4%), home care (73.1% *versus* 32.2%), physiotherapist contact (55.6% *versus* 50.5%) and GP contact (91.1% *versus* 75.4%) of which the latter happened more frequently

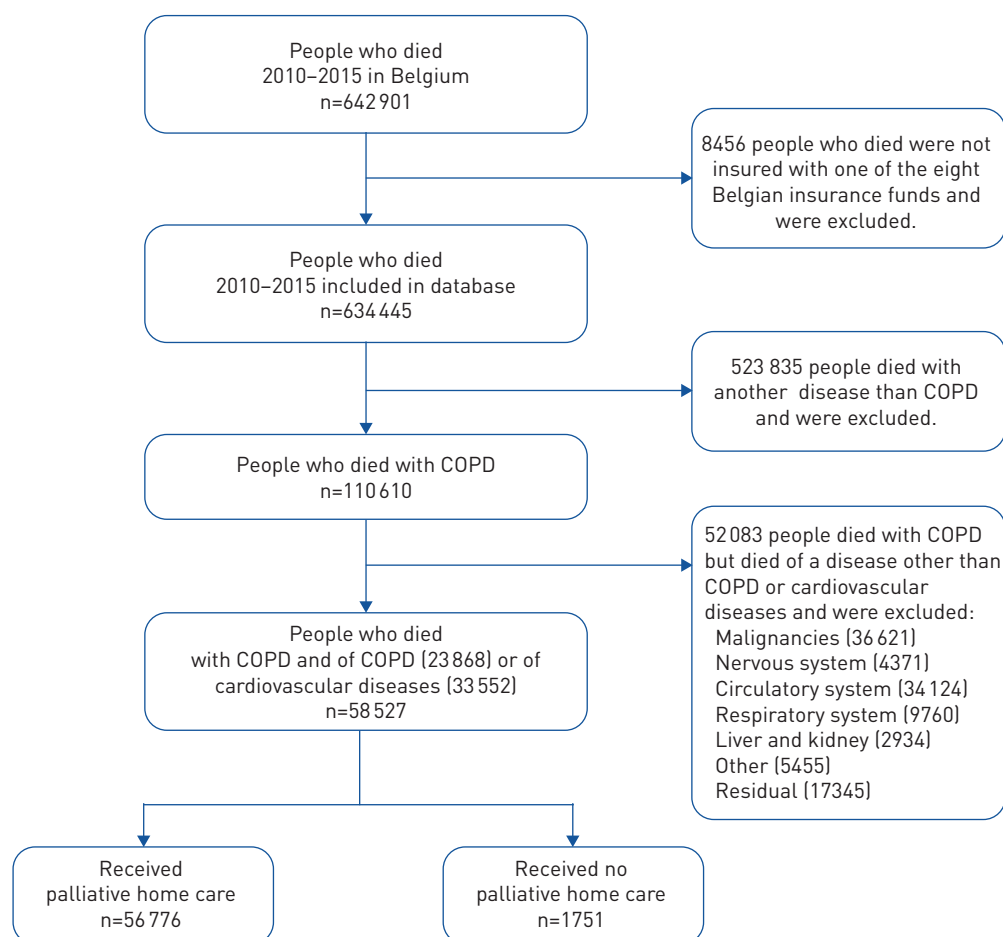


FIGURE 1 Flow chart of patients in the study.

(5.7 *versus* 2.4) ($p < 0.001$). Concerning procedures, they received less often invasive ventilation (1.2% *versus* 8.6%), cardiopulmonary resuscitation (0.3% *versus* 2.0%) and medical imaging including chest radiographs (27.0% *versus* 60.0%), but more often noninvasive ventilation (61.2% *versus* 24.0%) ($p < 0.001$). On medication, PHC users were administered sedatives less often (12.6% *versus* 20.0%), but more often oxygen (14.0% *versus* 6.0%), opioids (66.8% *versus* 33.1%) and morphine (43.3% *versus* 13.2%) ($p < 0.001$). Finally, they less often died in the hospital (15.6% *versus* 55.0%), but more often at home (60.8% *versus* 25.9%) or in a nursing home (23.6% *versus* 19.1%) ($p < 0.001$).

Multivariable tests (table 4) controlling simultaneously for the identified confounders (Appendix 1) confirmed these results, except for one-day care (not enough cases) and physiotherapist contact (not significant). Differences for length of stay at the intensive care unit, number of specialist and physiotherapist contact, gastric tube, urinary tract catheter, spirometry and COPD drugs were very small or not existent.

Furthermore, odds for medical resource use between the four PHC timing categories *versus* no PHC revealed that using PHC 90–31 days before death showed the largest increase for home care, non-invasive ventilation, opioids and morphine ($p < 0.001$) (figure 2a) and the largest decrease in all resource use variables from figure 2a except for nursing home deaths ($p < 0.001$). Appendix 3 shows detailed bivariate and multivariate results.

Healthcare costs

Descriptive healthcare cost results show that mean total inpatient costs were lower for people using PHC (€2492, 95% CI €2142–2841) than for those who did not (€5583, 95% CI €5526–5641). Mean total outpatient costs were higher for PHC use (€2542, 95% CI €2422–2661 *versus* €1020, 95% CI €1010–1029) and mean total healthcare costs were €1569 lower (€5034, 95% CI €4703–5364 *versus* €6603, 95% CI €6546–6659). Results per PHC timing category *versus* no PHC were similar, but using PHC 90–31 days before death showed the largest differences (table 5).

TABLE 2 Characteristics of COPD patients (using palliative home care)

Demographics	No palliative home care	Palliative home care >30 DBD ^f	p-value
Selected group[#]	56 776 (97.0)	644 (1.1)	
Sex[¶]			0.5483
Male	33 965 (59.8)	385 (59.8)	
Female	22 811 (40.2)	259 (40.2)	
Age years[¶]			0.0007
18–64	5548 (9.8)	75 (11.6)	
65–74	9897 (17.4)	127 (19.7)	
75–84	20 963 (36.9)	248 (38.5)	
85–94	18 581 (32.7)	179 (27.8)	
≥95	1744 (3.1)	14 (2.2)	
Educational level^{¶,+}			<0.0001
None	4276 (7.5)	54 (8.4)	
Primary	17 295 (30.5)	195 (30.3)	
Lower secondary	10 430 (18.4)	144 (22.4)	
Upper secondary	5925 (10.4)	79 (12.3)	
Higher	2988 (5.3)	48 (7.5)	
Household type[¶]			<0.0001
Single person	17 939 (31.6)	161 (25.0)	
Living together, with no children in household	21 207 (37.4)	317 (49.2)	
Living together, with children in household	4086 (7.2)	50 (7.8)	
One-parent family	2874 (5.1)	45 (7.0)	
Other household types	1320 (2.3)	13 (2.0)	
Collective (nursing home, psychiatric hospital)	9299 (16.4)	58 (9.0)	
Urbanisation[¶]			0.0018
Very high	17 157 (30.2)	196 (30.4)	
High	15 818 (27.9)	185 (28.7)	
Average	15 508 (27.3)	158 (24.5)	
Low	7015 (12.4)	93 (14.4)	
Rural	833 (1.5)	9 (1.4)	
Cause of death[¶]			<0.0001
COPD	23 497 (41.4)	371 (57.6)	
Cardiovascular disease	33 279 (58.6)	273 (42.4)	
Previous hospitalisations[¶]			
Mean LOS hospitalisations in the past 2 years until 30 DBD	38.1 (38.2–39.1)	51.6 (45.5–58.3)	<0.0001
Hospitalisations in the past 2 years until 30 DBD	2.6±2.7	4.2±3.6	<0.0001
Charlson Comorbidity Index[¶]			0.0217
0	48 790 (85.9)	559 (86.8)	
1	6847 (12.1)	52 (8.1)	
2	2083 (3.7)	26 (4.0)	
≥3	353 (0.6)	7 (1.1)	
Income^{¶,§}			0.9618
Lowest 40%	6107 (10.8)	78 (12.1)	
41–60%	31 916 (56.2)	367 (57.0)	
Region[¶]			<0.0001
Brussels capital region	33 021 (58.2)	361 (56.1)	
Flanders	19 372 (34.1)	236 (36.6)	
Wallonia	3938 (6.9)	44 (6.8)	
Unknown	445 (0.78)	3 (0.5)	

Data are presented as n (%), mean (range) or mean±SD, unless otherwise stated. DBD: days before death; LOS: length of stay. [#]: percentage of total population included in the database (n=58 527); [¶]: column percentages; ⁺: 28.0% missing values for no palliative home care and 21.0% for palliative home care; [§]: income percentages represent the proportion of the total population's income; ^f: 644 patients received palliative home care earlier than 30 days before death.

Discussion

Summary of the results

This population-level study using administrative data of 58 527 COPD who died between 2010 and 2015 shows that receiving PHC changes medical resource use in the last 30 days before death for people with COPD. Those using PHC (*versus* not using) were admitted to the hospital, emergency room and intensive care unit less often, received medical imaging (including chest radiographs), invasive ventilation and sedatives less often, and fewer of them died in hospital. More of them received home care, noninvasive

TABLE 3 Characteristics of COPD patients using palliative home care (PHC) in five timing categories

Demographics	PHC timing before death days				
	>360	360–181	180–91	90–31	30–1
Selected group[#]	110 [6.3]	129 [7.4]	143 [8.2]	262 [15.0]	1107 [63.2]
Time between first PHC use and death days	476 [410–555]	256 [214–301]	136 [110–161]	52 [41–69]	4 [1–11]
Sex[¶]					
Male	71 [64.5]	68 [52.7]	91 [63.6]	155 [59.2]	676 [61.1]
Female	39 [35.5]	61 [47.3]	52 [36.4]	107 [40.8]	432 [39.0]
Age years[¶]					
18–64	13 [11.8]	18 [14.0]	19 [13.3]	25 [9.5]	55 [5.0]
65–74	17 [15.5]	28 [21.7]	26 [18.2]	56 [21.4]	153 [13.8]
75–84	44 [40.0]	40 [31.0]	56 [39.2]	108 [41.2]	396 [35.8]
85–94	33 [30.0]	37 [28.7]	38 [26.6]	71 [27.1]	450 [40.7]
≥95	2 [1.8]	6 [4.7]	4 [2.8]	2 [0.8]	52 [4.7]
Educational level[¶]					
None	9 [8.2]	19 [14.7]	7 [4.9]	19 [7.3]	100 [9.0]
Primary	23 [20.9]	42 [32.6]	49 [34.3]	81 [30.9]	333 [30.1]
Lower secondary	22 [20.0]	26 [20.2]	32 [22.4]	64 [24.4]	232 [21.0]
Upper secondary	11 [10.0]	12 [9.3]	25 [17.5]	31 [11.8]	126 [11.4]
Higher	14 [12.7]	9 [7.0]	7 [4.9]	18 [6.9]	80 [7.2]
Household type[¶]					
Single person	30 [27.3]	36 [27.9]	34 [23.8]	61 [23.3]	250 [22.6]
Living together, with no children in household	50 [45.5]	60 [46.5]	77 [53.8]	130 [49.6]	496 [44.8]
Living together, with children in household	9 [8.2]	9 [7.0]	11 [7.7]	21 [8.0]	83 [7.5]
One-parent family	7 [6.4]	10 [7.8]	8 [5.6]	20 [7.6]	62 [5.6]
Other household types	2 [1.8]	1 [0.8]	1 [3.1]	9 [3.4]	19 [1.7]
Collective (nursing home, psychiatric hospital)	12 [10.9]	13 [10.1]	12 [8.4]	21 [8.0]	197 [17.8]
Urbanisation[¶]					
Very high	32 [29.1]	41 [31.8]	38 [26.6]	85 [32.4]	294 [26.6]
High	39 [35.5]	37 [28.7]	39 [27.3]	70 [26.7]	299 [27.0]
Average	20 [18.2]	28 [21.7]	43 [30.1]	67 [25.6]	304 [27.5]
Low	17 [15.5]	21 [16.3]	18 [12.6]	37 [14.1]	175 [15.8]
Rural	1 [0.9]	2 [1.6]	4 [2.8]	2 [0.8]	24 [2.2]
Cause of death[¶]					
COPD	61 [55.5]	83 [64.3]	77 [53.8]	150 [57.3]	535 [48.3]
Cardiovascular diseases	49 [44.5]	46 [35.7]	66 [46.2]	112 [42.7]	572 [51.7]
Previous hospitalisations[¶]					
Mean (range) LOS hospitalisations in the past 2 years until 30 DBD	48.8 [41.4–56.2]	46.0 [39.2–52.8]	57.5 [48.9–66.1]	52.4 [46.9–57.9]	NA
Hospitalisations past 2 years–30 DBD	3.9±2.8	3.9±3.2	4.4±3.4	4.4±3.6	NA
Charlson Comorbidity Index[¶]					
0	91 [82.7]	112 [86.8]	126 [88.1]	230 [87.8]	882 [79.7]
1	14 [12.7]	10 [7.8]	10 [7.0]	18 [6.9]	159 [14.4]
2	4 [3.6]	5 [3.9]	5 [3.5]	12 [4.6]	52 [4.7]
≥3	1 [0.9]	2 [1.6]	2 [1.4]	2 [0.8]	14 [1.3]
Income^{¶,*}					
Lowest 40%	9 [8.2]	19 [14.7]	19 [13.3]	31 [11.8]	107 [9.7]
41–60%	62 [56.4]	69 [53.5]	84 [58.7]	152 [58.0]	622 [56.2]
Highest 39%	39 [35.5]	41 [31.8]	40 [28.0]	79 [30.2]	378 [34.1]

Data are presented as n (%), median [interquartile range] or mean±SD, unless otherwise stated. LOS: length of stay; DBD: days before death. #: of the total population receiving palliative home care, n=1751 (1.1% of total population); ¶: Column percentages; *: income percentages represent the proportion of the total population's income.

ventilation, opioids and morphine, had GP contact, and died at home or in a nursing home. Mean total healthcare costs were €1569 lower (€5034, 95% CI €4703–5364 *versus* €6603, 95% CI €6546–6659). These results were similar for all four PHC timing categories (*versus* no PHC), although the differences for the majority of medical resources and costs were largest for those who used PHC 90–31 days before death.

Interpretation of the results

A first striking result was that PHC users had lower hospital-based and specialist medical resource use leading to lower inpatient costs than non-PHC users. This confirms previous research and advocates for

TABLE 4 Medical resource use in the last 30 days before death for COPD patients (using palliative home care [PHC])

Medical resource use and costs	Bivariate results		Multivariate results
	No PHC [#]	PHC >30 DBD [#]	PHC >30 DBD <i>versus</i> no PHC, OR [¶] (CI 95%)
Selected groups[§]	56 776 (97.0)	644 (1.1)	
Admissions and care interventions			
Hospital admission	27 169 (47.9)	159 (24.7)	0.35 (0.32–0.40)
LOS hospital admission	5.3 (5.2–5.4)	2.6 (2.3–2.9)	0.37 (0.34–0.42)
ICU admission	10 884 (19.2)	24 (3.7)	0.16 (0.12–0.20)
LOS ICU	1.0 (0.9–1.0)	0.1 (0.1–0.2)	0.16 (0.12–0.20)
Palliative care unit admission	780 (1.4)	49 (7.6)	2.61 (2.01–3.39)
LOS palliative care unit	0.1 (0.1–0.1)	0.3 (0.2–0.4)	2.63 (2.04–3.45)
ODC admission	1208 (2.1)	6 (0.9)	not enough cases
ER admission	22 360 (39.4)	126 (19.6)	0.43 (0.38–0.48)
Home care	18 294 (32.2)	471 (73.1)	3.27 (2.91–3.66)
GP contact	42 818 (75.4)	587 (91.1)	4.65 (3.77–5.74)
Number of GP contacts	2.4 (2.4–2.4)	5.7 (5.5–5.9)	5.26 (4.76–5.88)
Specialist contact	9566 (16.9)	59 (9.2)	0.58 (0.50–0.69)
Number of specialist contacts	0.2 (0.2–0.2)	0.1 (0.1–0.2)	0.61 (0.52–0.72)
Physiotherapist contact	28 643 (50.5)	358 (55.6)	0.94 (0.85–1.04)
Number of physiotherapist contacts	5.7 (5.6–5.8)	5.5 (5.1–5.8)	0.81 (0.74–0.89)
Procedures			
Invasive ventilation	4864 (8.6)	8 (1.2)	0.13 (0.08–0.21)
Noninvasive ventilation	13 795 (24.0)	394 (61.2)	2.65 (2.39–2.93)
Gastric tube	116 (0.2)	3 (0.5)	2.15 (1.11–4.16)
Urinary tract catheter	202 (0.4)	3 (0.5)	1.02 (0.44–2.34)
CPR	1031 (2.0)	2 (0.3)	0.09 (0.02–0.36)
Medical imaging	34 010 (60.0)	174 (27.0)	0.34 (0.31–0.38)
Chest radiograph	31 757 (56.0)	162 (25.2)	0.34 (0.31–0.38)
Number of chest radiographs	2.6 (2.5–2.6)	0.7 (0.6–0.8)	0.34 (0.31–0.38)
Spirometry	66 (0.1)	0 (0.0)	Not enough cases
Medication			
Oxygen	3473 (6.1)	90 (14.0)	2.22 (1.89–2.61)
Opioids	18 775 (33.1)	430 (66.8)	4.04 (3.63–4.49)
Sedatives	11 357 (20.0)	81 (12.6)	0.48 (0.41–0.57)
Morphine	7465 (13.2)	279 (43.3)	5.29 (4.78–5.86)
COPD drugs	35 319 (62.2)	411 (63.8)	0.97 (0.87–1.07)
Place of death ⁺			
Hospital death	31 225 (55.0)	274 (15.6)	0.14 (0.13–0.16)
Home death	14 731 (25.9)	1064 (60.8)	4.77 (4.29–5.30)
Death in nursing home or residence	10 820 (19.1)	413 (23.6)	1.72 (1.50–1.96)

Data are presented as n (%) or mean [95% CI], unless otherwise stated. DBD: days before death; LOS: length of stay (in days); ICU: intensive care unit; ODC: one day care; ER: emergency room; GP: general practitioner; CPR: cardiopulmonary resuscitation. [#]: column percentages; [¶]: odds ratios with reference category: no PHC, controlled for age, household type, attained educational level, urbanisation, year of death, amount of comorbidity, amount of home care visits with a palliative character from a community nurse in the last 360 days before death and care intensity parameters in the last 365 days before death [Appendix 1]; ⁺: for place of death, those who received PHC ≤ 30 DBD were also included, hence n=1751; [§]: percentage of total population included in the database (n=58 527).

better implementation of PHC in COPD. For example, hospitalisation occurred less often, similar to a 2016 hospital-based palliative care programme for COPD [8]. Dying at home also happened more (odds ratio 4.77), higher than the 2.21 odds ratio in a Cochrane review of 23 PHC trials for advanced illness (including COPD) but similar to a Belgian population study of chronically ill (including COPD) [13]. GP contact was high for both PHC users and non-users (91.1% and 75.4%), but differed in the frequency of contact (mean 5.7 *versus* 2.4). In comparison, MAETENS *et al.* [13] reported 3.1 *versus* 0.8 mean GP frequency in the final 14 days before death for chronically ill people.

Our results can also be related to a previous study that developed and validated quality indicators [26], *i.e.* “well-defined and measurable aspects of care” [27] to measure appropriate and inappropriate end-of-life care in COPD. This reveals that using PHC increases appropriate healthcare resources, such as GP contact,

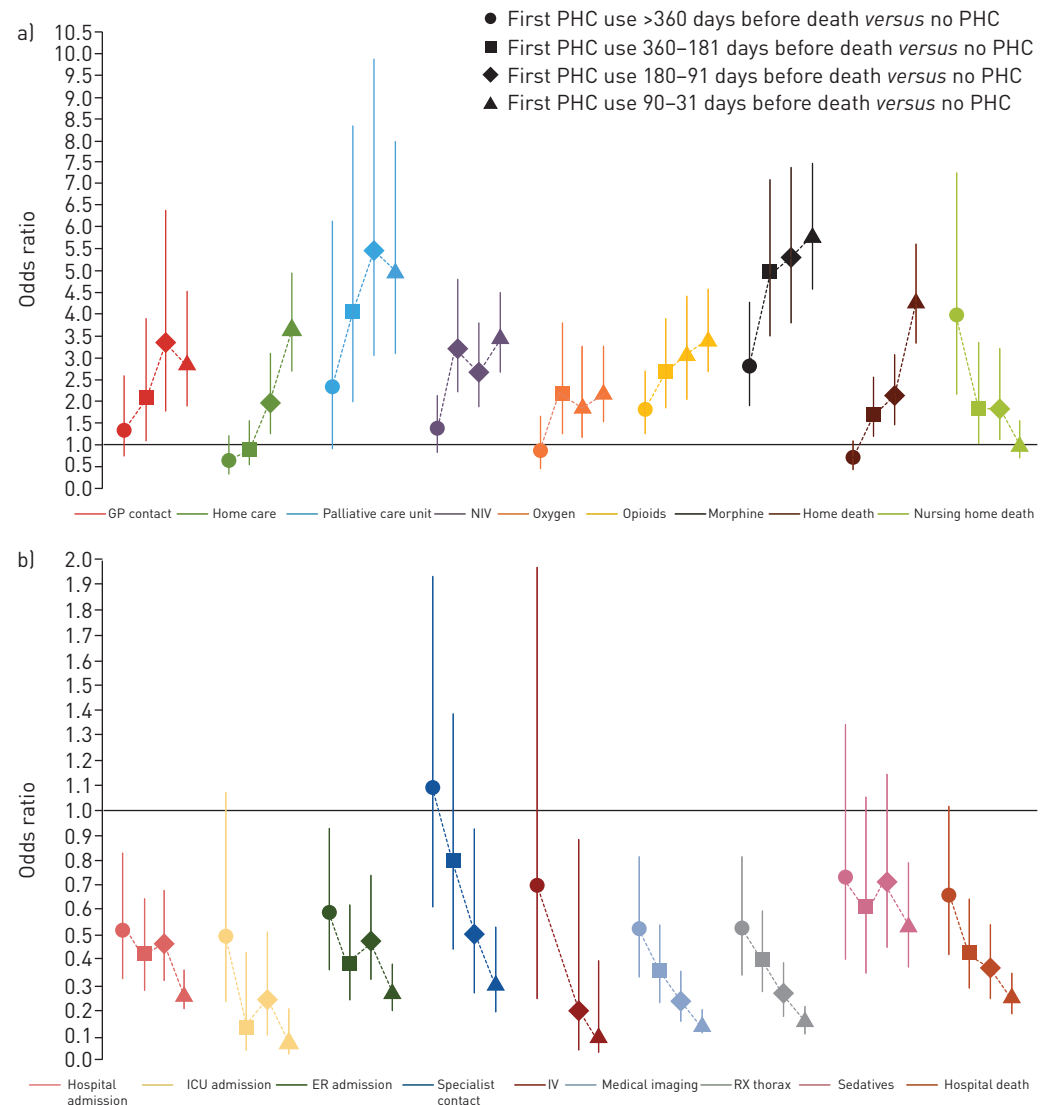


FIGURE 2 Medical resource use in the last 30 days before death for COPD patients (using palliative home care [PHC] >360, 360–181, 180–91 and 90–31 days before death). GP: general practitioner; NIV: noninvasive ventilation; ICU: intensive care unit; ER: emergency room; IV: invasive ventilation; RX: radiograph.

opioids, oxygen, home death or nursing home death [26]. This also somewhat confirms the GOLD guidelines which state that in the final stages of life, opioids may relieve breathlessness and oxygen may offer some benefit even if the patient is not hypoxaemic [28]. Likewise, we found indications of PHC decreasing inappropriate resource use, such as excessive admissions and medical imaging.

We observed very low (3.0%) and late PHC use (63.2% in last 30 days before death, with a median of four days) in all 58 527 COPD deaths. This is significantly lower than the 7.2% in a 2013 Flemish [3] and 13.5% in a Belgian study [13]. However, the latter included cancer patients, which probably explains the higher referral rate [29]. Frequently mentioned reasons for low and late referral in COPD are the unpredictable COPD trajectory and lower disease insight amongst patients in terms of severity, survival but also on the benefits of PHC [30]. Some health professionals believe PHC is not meaningful or too time-consuming in COPD [3]. Despite low and late PHC use, its association with more appropriate (in terms of disease stage) end-of-life care shows that health policy should take PHC better into account when designing care plans for COPD. Policy measures could try increasing PHC access by incorporating PHC knowledge and skills more effectively into educational programmes [31] and by creating public awareness campaigns about PHC and COPD [32].

The results on timing further revealed that all timing categories positively affect patient-centred medical resource use and lower inpatient and total costs in the last 30 days before death compared to no PHC.

TABLE 5 Healthcare costs in the last 30 days before death for COPD patients (using palliative home care (PHC))

Healthcare costs €	PHC use <i>versus</i> no PHC use				Timing of receiving PHC for the first time in days before death							
	No PHC (n=56 776)		PHC>30 DBD (n=644)		>360 (n=110)		360–181 (n=129)		180–91 (n=143)		90–31 (n=262)	
	Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)	Mean (95% CI)	Median (IQR)
Total inpatient costs	5583 (5526–5641)	2897 (0–9316)	2492 (2142–2841)	0 (0–3224)	2762 (1912–3611)	0 (0–4822)	2529 (1742–3316)	0 (0–2560)	3043 (2185–3902)	0 (0–4455)	2059 (1562–2556)	0 (0–2185)
Total outpatient costs	1020 (1010–1029)	734 (355–1365)	2542 (2422–2661)	2544 (1414–3380)	2286 (1990–2582)	2250 (1079–3181)	2347 (2115–2579)	2493 (1316–3180)	2421 (2179–2664)	2311 (1471–3370)	2811 (2612–3010)	2862 (1641–3626)
Total costs	6603 (6546–6659)	4265 (1248–10335)	5034 (4703–5364)	3555 (2497–6243)	5048 (4246–5850)	3237 (2239–7215)	4876 (4160–5593)	3489 (2169–5971)	5465 (4618–6312)	3453 (2157–7252)	4870 (4404–5335)	3633 (2776–5780)

DBD: days before death. All costs expressed in € at the 2017 rate. Costs were calculated using data on all reimbursed medical care costs and rounded. Total inpatient costs included all specific intervention and medication costs in the hospital. Total outpatient costs included all specific intervention and medication costs outside the hospital.

This aligns with patients' preferences to start palliative care earlier, according to a recent US-based study [33]. Still, of all timing categories, using PHC for the first time 90–31 days before death differed the most from not using PHC in terms of fewer hospital admissions, less medical imaging including chest radiographs, more prescriptions for opioids and morphine and more contact with GPs. This surprisingly late timing for the best effect does contrast somewhat with the large body of intervention studies [16, 34–37] and recommendations [6, 31, 38, 39] for early integration of palliative care (albeit mostly in cancer populations). We see three possible explanations.

Firstly, late (90–31 days before death) PHC users may have been in worse health than early (>360 days before death) users. This could explain the formers' higher patient-centred and comfort care to prepare for impending death. We controlled for worse health by measuring care intensity, such as hospital and intensive care unit admissions in the two years leading to death. Research in fact considers hospitalisation for an acute exacerbation a good predictor of poor health or even impending death in COPD [40]. Still, we could not measure all illness-related aspects of worse health that may influence resource use. For example, earlier PHC use may indicate higher uncertainty about prognosis, which may lead to different care choices in the last 30 days before death.

Second, our analysis did not account for possible differences in PHC intensity. As the data only allowed measuring first referral to PHC, earlier PHC users might have received fewer PHC visits or may even stopped PHC visits altogether before the final 30 days before death [38]. These patients could have returned to merely life-prolonging care. Finally, care preferences of health professionals or their views on the meaningfulness of PHC [3] and preferences of patients and family members [30] were impossible to assess but could have differed between PHC timing categories. Further research should take those in account for better analysis of medical resource use and costs. Despite these findings, our study still shows that, regardless of PHC timing, it affects medical resource use and costs in the same direction.

Strengths and limitations

This was, to our knowledge, the first retrospective population study of PHC use and timing on medical resource use and costs in the last 30 days before death for COPD. We were able to use full population data from Belgians who died between 2010 and 2015. Linking seven databases enabled medical resource use and cost analysis while considering socio-demographical confounders, leading to a large quantity of results on care interventions, admissions, procedures and medication use. Health policies designs can use this information concerning access or lack of access to PHC in the COPD population.

We acknowledge several limitations of our study. Firstly, because of the retrospective design, we may assume that all medical resources and costs happened for patients who were in the final stage of illness, while this might not be completely true [41]. Next, using administrative databases does not allow examination of specific patient, informal caregiver or health professional preferences that might have influenced medical decisions and patterns of medical service use.

Moreover, the severity of the disease or the number of exacerbations might also influence decisions on end-of-life resource use in the last 30 days before death for COPD. However, due to a lack of specific diagnostic information available on medical files, we could not account for such confounders. Nevertheless, a retrospective design did allow us to measure real-life performance in end-of-life care for COPD patients [42]. We also simulated the conditions (controlling for confounders, exposure to PHC before receiving medical resource use) for a randomised controlled trial in the best possible way.

A third limitation was the lack of data on services not covered by insurers, such as mobile hospital palliative care teams [18]. It was also impossible to gather information on PHC intensity (frequency of visits) because the data only provided information about the first PHC visit. We tried to solve this by controlling for the number of community nurse visits with a palliative nature, which could be an indicator for the frequency of PHC visits. Lastly, to identify those who died with COPD, we used a validated algorithm as well as the intermediate and associated causes of death indicated on the death certificates. However, by using the algorithm, it was impossible to determine the specific level of the disease from our data, since only dispensing data and not prescription data were available. Although there is no standard validated algorithm, the use of pharmacy data to identify COPD patients in administrative databases was found adequate in previous studies [43].

Conclusion

PHC use is strongly associated with increased appropriate patient-centred medical resource use and lower inpatient and total costs in the last 30 days before death for COPD compared to no PHC. Patients received more home care, noninvasive ventilation, opioids and morphine more often, had more contact with their GP and more of them died at home or in a nursing home. PHC given any time between 720 and 30 days

before death gave similar results. However, the largest differences were for the majority of medical resources and costs seen in using PHC 90–31 days before death. The results suggest that health policy and services should focus on increasing PHC access for COPD, while research should further explore the timing effects of early PHC for COPD.

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