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Impact of Integrated Care Model (ICM) on Direct Medical Costs in Management of Advanced Chronic Obstructive Pulmonary Disease (COPD)

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Background: Chronic obstructive pulmonary disease (COPD) is a commonly diagnosed condition in people older than 50 years of age. In advanced stage of this disease, integrated care (IC) is recommended as an optimal approach. IC allows for holistic and patient-focused care carried out at the patient's home. The aim of this study was to analyze the impact of IC on costs of care and on demand for medical services among patients included in IC.

Material/Methods: The study included 154 patients diagnosed with advanced COPD. Costs of care (general, COPD, and exacerbations-related) were evaluated for 1 year, including 6-months before and after implementing IC. The analysis included assessment of the number of medical procedures of various types before and after entering IC and changes in medical services providers.

Results: Direct medical costs of standard care in advanced COPD were 886.78 EUR per 6 months. Costs of care of all types decreased after introducing IC. Changes in COPD and exacerbation-related costs were statistically significant (p=0.012492 and p=0.017023, respectively). Patients less frequently used medical services for respiratory system and cardiovascular diseases. Similarly, the number of hospitalizations and visits to emergency medicine departments decreased (by 40.24% and 8.5%, respectively). The number of GP visits increased after introducing IC (by 7.14%).

Conclusions: The high costs of care in advanced COPD indicate the need for new forms of effective care. IC caused a decrease in costs and in the number of hospitalization, with a simultaneous increase in the number of GP visits.

MeSH Keywords: Delivery of Health Care, Integrated • Economics • Pulmonary Disease, Chronic Obstructive

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Background

COPD from pharmacoeconomic perspective

Chronic obstructive pulmonary disease (COPD) is a common chronic condition in people over the age of 50 years. Rapid population aging in developed countries is considered to be the main reason for higher prevalence of chronic diseases, including COPD. These changes will require some specific actions undertaken by health system decision-makers [1].

According to WHO estimates, there are more than 65 million people worldwide suffering from COPD. This is also an important health problem in Poland. It is estimated that 10.1–10.2% of Poles have COPD [2,3]. This is equivalent to approximately 2 million people, out of whom, 20% have an advanced stage of the disease (stage III and IV according to GOLD classification of obturation) [4].

COPD imposes a heavy economic burden on health systems. Expenditures are approximately EUR 38.6 billion a year, of which 40–75% is spent on treatment of exacerbations requiring hospitalization [5–9]. Therefore, preventing exacerbations is the biggest medical and economic challenge. Similarly, in Poland, unstable disease with frequent exacerbations is related to expenditures higher by PLN 1600/year (≈EUR 366.60) than in patients with stable disease [10]. In-hospital treatment of an exacerbation is up to 10 times more expensive than outpatient treatment [11].

Thus, to achieve more effective management of the disease, particularly in advanced COPD, an innovative type of care was proposed. The Integrated Care Model (ICM) is an intervention developed in Gdansk (Pomeranian Province, Poland). The main goal of ICM was to decrease the number of exacerbations and stabilize patient condition, thereby limiting National Health Fund (NHF) expenditures.

The intervention – Integrated Care Model (ICM)

ICM includes general and specialist care combined with home support for patients, and intensive education of patients and their relatives.

All actions are synchronized by the program coordinator, who is also responsible for supervising the proper use of drugs by the patients and coordinating their visits to GPs and pulmonologists (Figure 1).

As shown in Figure 1, the coordinator is responsible for providing ongoing support to the patients. This is a non-medical staff member who has completed a specialist course in a coordination of treatment of chronically ill patients, organized by a hospice foundation, who has participated in educational training on COPD, according to the educational program developed by one of the present co-authors – Iwona Damps-Konstanska, MD, PhD.

The coordinator provides patient support by:
- preparing the schedule of medical and non-medical activities for ICM patients;
- communicating with all ICM members;
- contacting patients by phone once every 2 weeks to assess their general health condition, if they are medication-compliant, and if they require attention of medical or non-medical staff;
- coordinating education of patients and their families by organizing trainings.

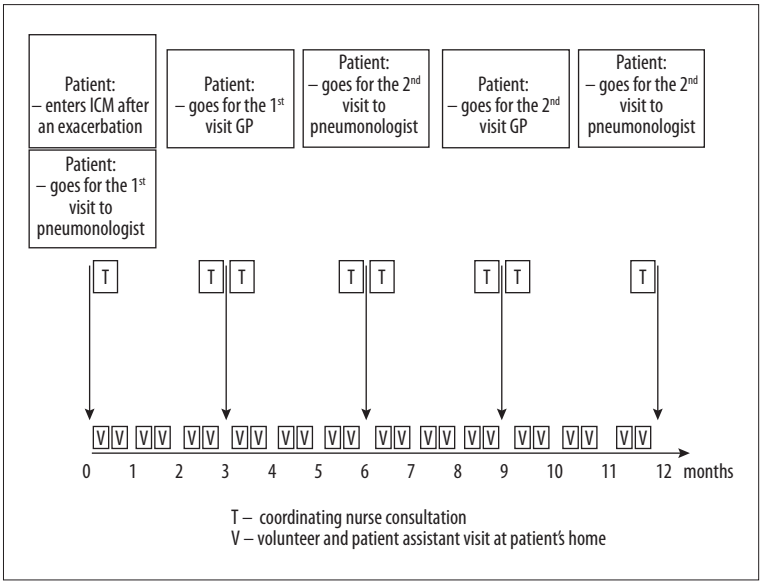

Figure 1. Scheme of ICM provided for Gdansk (Poland), made by the authors, based on Damps-Konstańska et al. [30].

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Table 1. Baseline characteristics of the study participants divided in two subgroups ICM-yes and ICM-no.

	ICM-yes	ICM-no
Age (average)	72	71
Age (median)	71	70
Sex	Male (n= 31; 70.45%)	Male (n=82; 62.60%)
	Female (n=13; 29.54%)	Female (n=49; 37.40%)

Within ICM there are 2 multidisciplinary teams working in close collaboration to assure optimal patient-oriented care.

1. The ICM medical team consists of:
– pulmonologists;
– medical doctors in other specializations, such as endocrinologists, cardiologists, or gastroenterologists (but only within standard care cooperation);
– GPs;
– nurses.

2. The ICM non- medical team consists of:
– patient assistants;
– dietitians;
– psychologists;
– physiotherapists;
– social workers;
– priests.

All team members are cooperating not only with each other but also with patients and their relatives. The innovative element is to integrate the activities of medical specialists and non-medical staff and to provide home support for patients with poor self-management and problems with compliance with medical recommendations.

Aim

The aim of this study was to estimate COPD costs and to analyze the impact of introducing integrated care (IC) on the public budget.

Secondary endpoints included the evaluation of:
– direct medical costs for patients included and not included in ICM;
– changes in costs before and after including patients in ICM;
– changes in the frequency of using specific types of medical services.

Material and Methods

Study population

The study included 175 patients diagnosed with advanced COPD. The mean age of the study group was 71 years old (46–88 years) and 65% were men. The baseline characteristics are presented in Table 1.

Cost analysis

This was a "before-after" study. The first period, called "intro-6m" (meaning 6 months before introducing ICM), included 6 months of standard treatment received by all the patients. After 6 months, the study group was divided into 2 subgroups:
– subgroup 1 called "ICM-no" continued standard type of care (n=131);
– subgroup 2 called "ICM-yes" received integrated care (n=44).

The observation lasted for another 6 months after dividing patients into subgroups (the period called "intro+6m"). Based on prior studies on IC, the study included patients who fulfilled the specified criteria (Figure 2).

Finally, the cost analysis included 154 patients. The dropouts from the study were a result of: death during the observation period (n=16), lack of COPD-related costs (n=2), and exacerbation costs (n=87). The cost analysis was divided into 3 stages. The types of costs analyzed in the study are presented in Table 2.

Selection of DRG (*Diagnosis-Related Groups*) codes to describe the list of services included in the particular stages of the analysis was done on the basis of the clinical expertise of the 2 authors independently. The cost data were provided by the NHF and covered the time period from September 2012 to the end of June 2014.

The analysis included the following steps:
1. Calculating costs of standard care for all the patients included in the study;
2. Calculating costs of IC for patients fulfilling the specified criteria (Figure 2);

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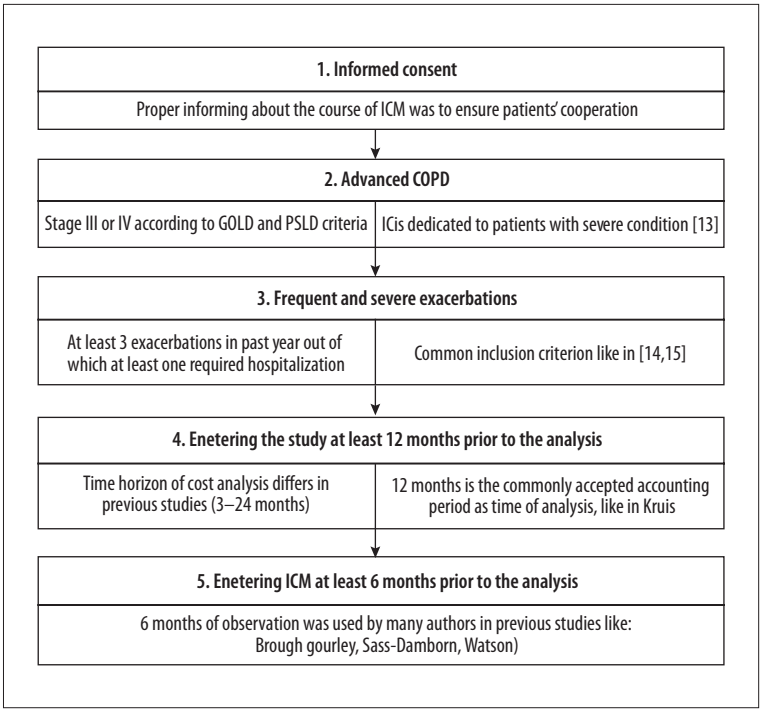

Figure 2. Criteria for including patients in the particular study groups [31–38].

Table 2. Stages of cost analysis with types of costs included.

Stage of analysis	Type of costs	Type of procedures included
I	General	All medical procedures realized for patients
II	COPD related	Medical procedures realized due to COPD and other diseases of the respiratory system (the list of DRG codes of diseases and conditions requiring medical procedures included in stage II is available in Supplementary Table 1)
III	Exacerbation related (ER)	Medical procedures realized due to exacerbations of COPD (the list of DRG codes of diseases and conditions requiring medical procedures included in stage III is available in Supplementary Table 2).

3. Estimating changes in values of costs of all types (Table 2);
4. Assessing changes in types of medical procedures after replacing SC with IC;
5. Assessing changes in types of medical services providers engaged into taking care of patients after replacing SC with IC.

Statistical analysis

All calculations were carried out using Microsoft Excel spreadsheets and the STATISTICA, StatSoft Inc. version 8.0. statistical package. The normality of the variables distribution and variance equality of a studied feature in groups were tested using both an appropriate Shapiro-Wilk's test and a variance equality test. When assessing changes in time, the Wilcoxon's matched-pairs signed-rank test was used. In all the calculations, the statistical significance level was set to $p<0.05$.

Results

First, the standard care costs for 6 months were evaluated for all the patients included in the cost analysis (n=154). The average half-year cost was PLN 3870.26 (≈EUR 886.78), whereas the maximal cost exceeded PLN 4500 (≈ EUR 10310.69) (Table 3).

The next step was to assess the changes in values of 3 costs types after implementation of ICM to the group of patients who fulfilled the criteria and were included in ICM. The summary data on cost changes is presented in Table 4.

General costs

General costs were analyzed in 2 consecutive periods: before and after including patients into ICM. We found that general

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Table 3. Direct medical costs of standard care in patients with COPD divided into: general costs, system related costs of COPD and other diseases of the respiratory system and related costs of exacerbations of COPD (in PLN).

Type of cost	N	Mean	Median	Dominant	Dominant representation	Minimal value	Maximal value
General costs in intro-6m	154	3870.26 (≈886.78 EUR)	1087.18 (≈249.10 EUR)	0	18	0	45456.91 (≈10415.38 EUR)
COPD costs in intro-6m	152	1599.03 (≈366.38 EUR)	91.35 (≈20.93 EUR)	0	46	0	20071.54 (≈4598.92 EUR)
ER costs in intro-6m	65	1571.28 (≈360.02 EUR)	0	0	34	0	20010.64 (≈4584.97 EUR)

Table 4. Direct medical costs of three types of before and after, including patients in ICM (group ICM-yes) (in PLN and EUR) with results of Wilcoxon's Matched-Pairs Signed-Rank test.

Period	N	Mean	Median	Dominant	Dominant representation	Min. value	Max. value	p value
General costs								
Intro-6m	41	5627.29 (≈1289.36EUR)	3708.72 (»849.77 EUR)	0	1	30.45 (≈6.98 EUR)	29671.15 (≈6798.45 EUR)	0.079114
Intro+6m	41	3576.79 (≈819.54 EUR)	2388.4 (»547.25 EUR)	0	2	0	16765.1 (≈3841.33 EUR)	
COPD and other respiratory system disease costs								
Intro-6m	41	3191.43 (≈731.24EUR)	2168.1 (»496.77 EUR)	0	3	0	20071.54 (≈4598.92 EUR)	0.012492
Intro+6m	41	1741.31 (≈398.98 EUR)	157.5 (»36.09 EUR)	0	6	0	9314.65 (≈2134.23 EUR)	
Exacerbation costs								
Intro-6m	26	2443.61 (≈559.9EUR)	1872 (»428.92EUR)	0	7	0	20010.64 (≈4584.97EUR)	0.017023
Intro+6m	26	735.17 (≈168.45EUR)	0	0	18	0	5539.5 (≈1269.25EUR)	

direct medical costs decreased. Both average and median values were reduced to PLN 2050.50 (≈EUR 469.82) and PLN 1319.93 (≈EUR 302.43), respectively, after 6 months of ICM. However, the Wilcoxon's signed-rank test showed no statistical significance of the differences in the distribution of parameters (p=0.079114).

COPD costs

The costs related to COPD and other respiratory system diseases decreased significantly (Wilcoxon's Matched-Pairs Signed-Rank p=0.012492). Both average and median values were reduced to PLN 1450.12 (≈EUR 332.26) and PLN 2010.60 (≈EUR 460.68), respectively, after 6 months of ICM.

Exacerbation costs

The last stage of cost analysis was to assess exacerbation-related costs. These costs also decreased significantly (Wilcoxon's matched-pairs signed-rank p=0.017023). Both average and median costs were lowered to PLN 1708.44 (≈EUR 391.45) and PLN 1872.00 (≈EUR 428.92), respectively, after 6 months of ICM. Median costs after introducing ICM were PLN 0 (EUR 0). Eighteen (approximately 70%) of the 26 patients included in this stage of the cost analysis had no exacerbation-related costs during 6 months of ICM.

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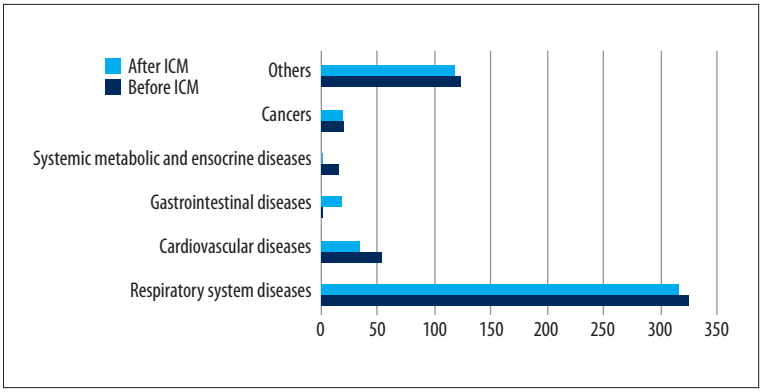

Figure 3. The number of medical services provided before and after ICM in treatment of health conditions.

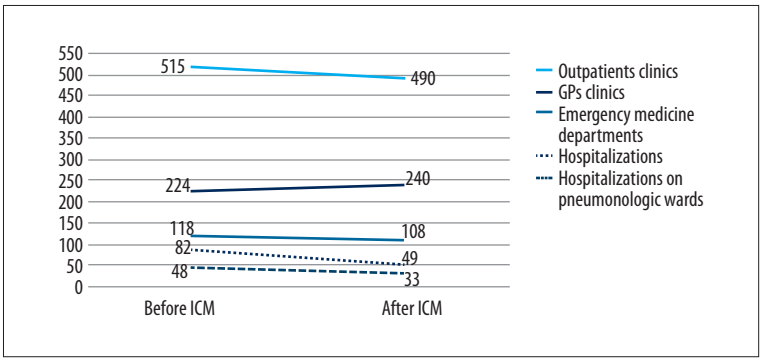

Figure 4. The number of medical services provided by different types of providers before and after ICM.

Changes in the number of medical procedures provided for patients

After including patients in ICM, the number of medical procedures used in treating their health condition changed. There was a decrease in the number of medical services provided in most of the cases, except from gastrointestinal diseases (Figure 3).

A similar comparison was done for the type of medical services provider. The number of services provided by GPs increased along with a decrease in the number of hospitalizations and services provided by emergency departments and paramedic teams (Figure 4).

Discussion

According to numerous studies, IC is a relevant and essential medical technology in the management of advanced COPD [12–14]. At the present time, it seems reasonable to determine the economic effectiveness of this technology with the use of pharmacoeconomic tools. In Poland, the role of pharmacoeconomic analyses is systematically growing and they are currently used for assessing all new and expensive procedures. They are particularly important in selecting optimal medical technologies for managing chronic diseases, including COPD, as these conditions are related to particularly high costs [11-17].

Back in 2007, in Poland, it was found that the average direct medical costs of COPD were PLN 4027 per 1 year (≈EUR 922.69) [10]. In the present study, after 8 years, the average costs were PLN 3191.43 per 6 months (≈EUR 731.24) when standard care was used. Nevertheless, in our study, we decided to analyze not only COPD-related costs, but also costs of all procedures provided for patients, as it has already been proven that assessing only COPD costs is not sufficient for the meticulous calculation of actual economic burden, mainly due to the presence of multiple co-morbidities [10,18,19].

Furthermore, earlier studies showed that severity of COPD is related to cost of care [8], especially costs due to frequent hospitalizations [20]. This is one reason why ICM should be indicated for patients with advanced COPD with severe and very severe obstruction of the airways.

The cost analysis proved that patients fulfilling the criteria for participation in ICM were in a worse health status, which was confirmed by higher costs of care in the primary assessment. By comparing costs calculated for all patients (n=154) and for the ICM-yes group in the period before introducing ICM, we noticed that the costs were lower: 31% lower for general costs, 49% lower for COPD costs, and 36% lower for exacerbation costs. This confirms that the correct inclusion criteria were planned for the study, as the intention of the authors was to make ICM available for the patients in more severe condition.

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In numerous "before-after" studies, authors found that implementing IC results in savings. In the Steuten et al. study, the decrease in direct medical costs was EUR 42 [21]. In our study, the difference between average costs was even greater (PLN 2050.48 ≈EUR 489). Even after taking into account that ICM requires additional financing (PLN 915.18/6 months/1patient ≈EUR 209.69), in 1 year it is still possible to save EUR 543 per patient. This shows that the construction of the model proposed

Table 5. Comparison of studies dealing with integrated care.

Author (year)	IC programme country	Types of intervention used	Main assumptions of ICM
Base for comparison – main assumption of ICM Poland			
Bandurska et al. (2016)	Poland	1. Cooperation between specialist and general care 2. Coordination of treatment 3. Supervision of patient's compliance 4. Home care 5. Education and promotion of self-management 6. Support of multidisciplinary team	A. Study construction – Pre-post study – 6 months follow up after introducing IC – Multivariate cost analysis B. IC model construction – Home based support – Supervision of compliance – Multidisciplinary team – Education for patients and families – ICM available for patients in advanced COPD. C. Results obtained – Reduction in costs – Reduction in prevalence of hospitalizations and ER visits – More services realized by GPs and ambulatory clinics
Comparison with IC studies			
Author (year)	**IC programme country**	**Types of intervention used**	**Similarities (ICM) In study design. In IC model construction. In results obtained**
Boven et al. (2014)	Belgium	1. Supervision of patient's compliance	A. – Multivariate cost analysis – Analysis of changes in number of hospitalizations B. – Supervision of patient's compliance and inhaling technique C. – Savings after introducing IC – Reduction in number of hospitalizations
Steuten et al.	Netherlands	1. Support of multidisciplinary team. 2. Education and promotion of self-management. 3. Coordination of treatment 4. Supervision of patient's compliance	A. – Pre-post test design – 3 months follow up B. – Multidisciplinary team cooperation – Education and promotion of self-management C. – Reduction in number of hospitalizations

Author (year)	Differences (ICM) In study design. In IC model construction. In results obtained	Positive impact of IC
Boven et al. (2014)	A. – 12 months follow-up B. – Pharmacy based intervention – Focused on compliance to pharmaceutical treatment C. – Other type of pharmacoeconomic analysis used – QALY assessment	– Savings of 227 EUR/year/patient – Prevention of 0.07 hospitalization/patient
Steuten et al.	A. – Cost analysis of losses of productivity; – 12 months follow-up B. – Lack of home care C. – No significant savings found after introducing IC	– Reduction in hospitalization by 50% – Reduction in non-routine consultations by 25%

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Table 5 continous. Comparison of studies dealing with integrated care.

Author (year)	IC programme country	Types of intervention used	Similarities (ICM) In study design. In IC model construction. In results obtained	Differences (ICM) In study design. In IC model construction. In results obtained	Positive impact of IC
Hermiz et al. (2002)	Australia	1. Supervision of patient's compliance 2. Home care 3. Education and promotion of self-management	A. – Analysis of number of hospitalizations B. – Home and telephone visits C. – None	A. – Analysis of effects without costs assessment – 1 month follow-up B. – No multidisciplinary team – No coordination of treatment C. – No reduction in number of hospitalizations	– Improved knowledge about disease among patients
Casas et al. (2006)	Belgium, Spain	1. Coordination of treatment (individual treatment plan) 2. Multidisciplinary team 3. Web-based centre 4. Education and promotion of self-management	A. – Analysis of number of hospitalizations B. – Engagement of GPs – Coordination of treatment – Education of patients C. – Reduction of hospitalizations	A. – No cost analysis – 12 months follow up after IC B. – Web-based centre – Lack of home care C. – Decrease in number of GPs visits	– Lower number of re-hospitalizations – 1.5±2.6 versus 2.1±3.1.
Titova et al. (2015)	Norway	1. Coordination of treatment (individual treatment plan) 2. Multidisciplinary team 3. Call centre 4. Education and promotion of self-management	A. – IC available only for patients with advanced COPD (stage III–IV GOLD) – Analysis of hospital utilization B. – Multidisciplinary team – Coordination of treatment – Education of patients C. – Reduction in hospital utilization	A. – 2 years follow-up – No cost analysis B. – E-learning programme for patients C. – No cost specific data to compare	– Reduction in hospital utilization
Boland et al. (2015)	Netherlands	1. Coordination of treatment (individual treatment plan) 2. Multidisciplinary team 3. ICT programme to support clinical decision-making 4. Clusters of primary care teams	A. – Analysis of impact of IC on costs B. – Coordination of treatment (individual treatment plan) – Multidisciplinary team C. – None	A. – 2 years follow-up – Clusters of primary care teams B. – ICT programme to support clinical decision-making – No reduction of costs in IC group	– None

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in Gdansk is well adjusted to the needs of COPD patients and might be an important tool for managing COPD and limiting health system expenditures. ICM is a complex intervention that includes medical and non-medical staff support provided at patients' homes, cooperation of specialist care with GPs, and supervision of adherence to medical recommendations (for a comparison of elements available for patients, see Table 5). A similar observation concerning the positive impact of integrated care on costs was found in 2014 by van Boven et al. [22], who reported savings of EUR 227 per patient.

It is worth noting, though, that no statistically significant changes were found in general costs. However, after entering ICM, patients visited specialists such as dermatologists or dentists more often, which influenced the general costs. We perceive this phenomenon as positive, and it might indicate that health status improved and patients were able to use medical services that were out of reach for them before entering ICM because of poor health.

The statistically significant decrease in the COPD costs indicates that fewer procedures were provided after including patients in ICM. We believe that many health needs were satisfied by ICM and no additional procedures were necessary. Therefore, ICM seems to be appropriate for patients with advanced COPD.

Numerous have studies concentrated on the significance of preventing exacerbations that require hospitalizations [23]. This is particularly important because an exacerbation requiring hospitalization usually results in significant deterioration in health status [6].

The decrease noticed in the exacerbation-related costs may also be considered as a decreasing number of exacerbations. Before ICM was implemented, approximately 47.7% of patients required medical services typical for exacerbations (Table 3). In the group of patients meeting the criteria of inclusion to ICM, the prevalence was even higher; exacerbation-related procedures were provided for 73% of patients. After 6 month of ICM in the group "ICM-yes" only 31% of patients required procedures provided for exacerbations. A similar observation was recently made by Titova et al., who noticed a difference in the number of hospitalizations between patients receiving IC and those receiving regular care (12.6% reduction in the first year and 46.5% reduction during the second year of follow-up, in comparison to 8.3% increase in the first year and no change during the second year of follow-up) [24].

These results seem to be encouraging. Furthermore, it is worth noting that ICM seems to be more effective than many IC models described by other authors [22,25]. For example, in a recent study by Hernandez et al., there was no reduction in the number of hospital admission found in IC in comparison with SC for stable patients [26]. Some authors found no economic efficacy of integrated care [27]. In a recently published cluster study on cost-effectiveness of IC in COPD, no economic benefit was found [28]. Table 5 shows differences and similarities between studies dealing with IC in COPD.

As contemporary knowledge of the economic effectiveness of integrated care is still not clear, the present study, conducted in Gdansk, proves ICM is an effective tool. We hope our results will be important in the worldwide discussion regarding designing effective models of care for patients and the healthcare system finances.

Conclusions

We found that ICM is a beneficial intervention for patients and the public payer. After including patients in ICM, their demand for medical services changed. The patients were rarely hospitalized and used services provided by outpatient clinics more often. Fewer procedures were continued in treating respiratory system disorders, which might indicate an improvement in the health of ICM patients.

The costs of care provided for advanced COPD patients are high, which indicates a need to evaluate traditionally used medical services and to looking for more effective ones, both from the medical and economic point of view. It seems that ICM meets these criteria, as medical costs of all analyzed types decreased when standard care was replaced by IC. Statistically significant changes were observed in costs related to COPD and exacerbations.

The obtained results show that ICM can be an effective tool to manage advanced COPD, because it reduces the number of exacerbations and therefore limits public expenditures.

Implications

This article is particularly relevant in countries where integrated care is still being implemented [29]. For specialists already using integrated care, this study confirms that IC can benefit COPD patients and the healthcare system. In countries that are still adjusting their health system to current and future challenges (e.g., demographic changes), the results obtained in Gdansk can be a guide to choosing a beneficial model of care. After an analysis of the literature on IC, it is clear that scientific discussion on the effectiveness of this type of care is still open.

Limitations

This study has some limitations. The number of patients included in ICM was small because ICM still has no stable source

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of financing and is not financed from the budget of the NHF. Another limitation was using the public payer perspective in the cost analysis instead of the societal one, which is considered to be the most extensive and complete. In Poland, conducting cost analysis from the societal perspective is very difficult due to a limited access to data that is highly dispersed and collected on a fragmentary basis by various institutions. Due to using the public payer perspective, it was impossible to assess indirect costs.

Acknowledgments

We wish to thank all the people engaged in ICM.

Conflict of interest

Authors declare no conflict of interest.

Supplementary Tables

Supplementary Table 1. List of diseases and related health problems requiring procedures qualified to costs of COPD and other diseases of respiratory system

ICD-10 code	Name	Reason for inclusion
I26	Pulmonary embolism	Frequent cause of death
I26.9	Pulmonary embolism without mention of acute cor pulmonale	Frequent cause of death
I27	Other pulmonary heart diseases	Frequent cause of death
I27.8	Other specified pulmonary heart diseases	Frequent cause of death
I27.9	Pulmonary heart disease, unspecified	Frequent cause of death
J00	Acute nasopharyngitis	Frequent occurrence in patients with COPD
J02	Acute pharyngitis	Frequent occurrence in patients with COPD
J03	Acute tonsillitis	Frequent occurrence in patients with COPD
J04	Acute laryngitis and tracheitis	Frequent occurrence in patients with COPD
J06	Acute upper respiratory infections of multiple and unspecified sites	Frequent occurrence in patients with COPD
J13	Pneumonia due to Streptococcus pneumoniae	Frequent occurrence in patients with COPD
J15	Bacterial pneumonia, not elsewhere classified	Frequent occurrence in patients with COPD
J15.1	Pneumonia due to Pseudomonas	Frequent occurrence in patients with COPD
J15.4	Pneumonia due to other streptococci	Frequent occurrence in patients with COPD
J15.5	Pneumonia due to Escherichia coli	Frequent occurrence in patients with COPD
J15.6	Pneumonia due to other aerobic Gram-negative bacteria	Frequent occurrence in patients with COPD
J15.8	Other bacterial pneumonia	Frequent occurrence in patients with COPD
J15.9	Bacterial pneumonia, unspecified	Frequent occurrence in patients with COPD
J16	Pneumonia due to other infectious organisms, not elsewhere classified	Frequent occurrence in patients with COPD
J16.8	Pneumonia due to other specified infectious organisms	Frequent occurrence in patients with COPD
J18	Pneumonia, organism unspecified	Frequent occurrence in patients with COPD
J18.9	Pneumonia, unspecified	Frequent occurrence in patients with COPD
J20	Acute bronchitis	Frequent occurrence in patients with COPD
J20.9	Acute bronchitis, unspecified	Frequent occurrence in patients with COPD
J21	Acute bronchiolitis	Frequent occurrence in patients with COPD

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ICD-10 code	Name	Reason for inclusion
J22	Unspecified acute lower respiratory infection	Frequent occurrence in patients with COPD
J31	Chronic rhinitis, nasopharyngitis and pharyngitis	In connection with the use of inhalers
J32.4	Chronic pansinusitis	Frequent occurrence in patients with COPD
J37	Chronic laryngitis and laryngotracheitis	Frequent occurrence in patients with COPD
J39	Other diseases of upper respiratory tract	Frequent occurrence in patients with COPD
J39.2	Other diseases of pharynx	Frequent occurrence in patients with COPD
J40	Bronchitis, not specified as acute or chronic	Frequent occurrence in patients with COPD
J41	Simple and mucopurulent chronic bronchitis	Frequent occurrence in patients with COPD
J41.0	Simple chronic bronchitis	Frequent occurrence in patients with COPD
J41.8	Mixed simple and mucopurulent chronic bronchitis	Frequent occurrence in patients with COPD
J42	Unspecified chronic bronchitis	Frequent occurrence in patients with COPD
J43	Emphysema	Frequent occurrence in patients with COPD
J43.8	Other emphysem	Frequent occurrence in patients with COPD
J43.9	Emphysema, unspecified	Frequent occurrence in patients with COPD
J44	Other chronic obstructive pulmonary disease	Code assigned for COPD
J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection	Frequent occurrence in patients with COPD
J44.1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	Frequent occurrence in patients with COPD
J44.8	Other specified chronic obstructive pulmonary disease	Frequent occurrence in patients with COPD
J44.9	Chronic obstructive pulmonary disease, unspecified	Frequent occurrence in patients with COPD
J45	Asthma	Difficult in differentiation with COPD (especially at the level of care primary care)
J45.0	Predominantly allergic asthma	Difficult in differentiation with COPD (especially at the level of care primary care)
J45.1	Nonallergic asthma	Difficult in differentiation with COPD (especially at the level of care primary care)
J45.8	Mixed asthma	Difficult in differentiation with COPD (especially at the level of care primary care)
J45.9	Asthma, unspecified	Difficult in differentiation with COPD (especially at the level of care primary care)
J46	Status asthmaticus	Difficult in differentiation with COPD (especially at the level of care primary care)
J47	Bronchiectasis	Difficult in differentiation with COPD (especially at the level of care primary care)
J84	Other interstitial pulmonary diseases	Frequent occurrence in patients with COPD
J84.1	Other interstitial pulmonary diseases with fibrosis	Frequent occurrence in patients with COPD
J84.8	Other specified interstitial pulmonary diseases	Frequent occurrence in patients with COPD
J84.9	Interstitial pulmonary disease, unspecified	Frequent occurrence in patients with COPD
J85.1	Abscess of lung with pneumonia	Frequent occurrence in patients with COPD
J93	Pneumothorax	Frequent occurrence in patients with COPD
J93.1	Spontaneous tension pneumothorax	Frequent occurrence in patients with COPD

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ICD-10 code	Name	Reason for inclusion
J93.8	Other pneumothorax	Frequent occurrence in patients with COPD
J94	Other pleural conditions	Frequent occurrence in patients with COPD
J96	Respiratory failure, not elsewhere classified	Frequent occurrence in patients with COPD
J96.0	Acute respiratory failure	Frequent occurrence in patients with COPD
J96.1	Chronic respiratory failure	Frequent occurrence in patients with COPD
J96.9	Respiratory failure, unspecified	Frequent occurrence in patients with COPD
J98	Other respiratory disorder	Frequent occurrence in patients with COPD
J98.4	Other disorders of lung	Frequent occurrence in patients with COPD
J98.8	Other specified respiratory disorders	Frequent occurrence in patients with COPD
J98.9	Respiratory disorder, unspecified	Frequent occurrence in patients with COPD
J99	Respiratory disorders in diseases classified elsewhere	Frequent occurrence in patients with COPD
K13	Other diseases of lip and oral mucosa	In connection with the use of inhalers
L25	Unspecified contact dermatitis	In connection with the use of inhalers
R04	Haemorrhage from respiratory passages	Frequent occurrence in patients with COPD
R04.2	Haemoptysis	Frequent occurrence in patients with COPD
R05	Cough	Frequent occurrence in patients with COPD
R06	Abnormalities of breathing	Frequent occurrence in patients with COPD
R06.0	Dyspnoea	Frequent occurrence in patients with COPD
R07	Pain in throat and chest	Frequent occurrence in patients with COPD
R07.1	Chest pain on breathing	Frequent occurrence in patients with COPD
R07.3	Other chest pain	Frequent occurrence in patients with COPD
R07.4	Chest pain, unspecified	Frequent occurrence in patients with COPD
R09.8	Other specified symptoms and signs involving the circulatory and respiratory systems	Frequent occurrence in patients with COPD
R91	Abnormal findings on diagnostic imaging of lung	Frequent occurrence in patients with COPD

Supplementary Table 2. The list of diseases and related health problems requiring procedures qualified to costs of exacerbations of COPD

ICD-10 code	Name	Reason for inclusion
J44.1	Chronic obstructive pulmonary disease with acute exacerbation, unspecified	Assigned for exacerbation of COPD
J44.0	Chronic obstructive pulmonary disease with acute lower respiratory infection	Frequently used for exacerbation of COPD
J22	Unspecified acute lower respiratory infection	Frequently used for exacerbation of COPD
J96	Respiratory failure, not elsewhere classified	Frequently used for exacerbation of COPD
J96.0	Acute respiratory failure	Frequently used for exacerbation of COPD
J96.9	Respiratory failure, unspecified	Frequently used for exacerbation of COPD
J46	Status asthmaticus	Frequently used for exacerbation of COPD

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