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Research Article

Outpatient-Based Pulmonary Rehabilitation for COPD: A Cost of Illness Study

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Pulmonary rehabilitation (PR) as recommended by COPD guidelines is a multimodality educational, self-management, supervised exercise program, resulting in improved symptom control, quality of life, and reduction of exacerbations, but there is a need to establish the affordability of PR for healthcare providers. We designed a cost-of-illness study of PR in advanced COPD, with an 8-week hospital-based program, measuring direct healthcare costs for 12 months before and after PR. In 31 patients (female = 16), aged 68 ($\pm$8) years, and FEV_1% predicted to be 40 ($\pm$16.6), there was a reduction in inpatient hospital stay by net 2.35 days (78%; $P = 0.027$) and routine primary care visits. Costs were reduced by £1835 per person (base year 2008), with a saving of £791 to 1313 GBP per person, per year. Therefore, PR provision in COPD is likely to be affordable due to reduced direct healthcare costs, even without considering the individual and societal benefits.

1. Introduction

The cost burden associated with chronic bronchitis and emphysema, collectively known as chronic obstructive pulmonary disease (COPD), is large. The disease impacts not only patients but caregivers and society as well [1]. Smoking cessation, comprehensive rehabilitation, and long-term oxygen therapy are widely accepted as therapies, which may positively impact the long-term management of COPD patients [2]. Multicomponent Pulmonary Rehabilitation (PR) programs are currently recommended in national and international COPD guidelines. Exercise training is the corner stone of a comprehensive, multidisciplinary PR in COPD and has been shown to improve health-related quality of life (HRQL) and exercise capacity [3]. Outpatient PR has been shown to result in significant and clinically relevant changes in 6-minute walking distance, maximal exercise performance, peripheral and respiratory muscle strength, and HRQL [4]. Although PR is considered to demonstrate a positive impact on patient outcomes [5], not every COPD patient responds well and the effectiveness on altering the natural history of COPD and utilization of healthcare resources is often debatable. The major area for achieving cost savings is by reducing hospital utilization [6]. Some authors argue that there is little evidence for significant improvements in the process and intermediate outcomes from PR programs, except for increased provision of patient self-management education and improved disease-specific knowledge. Education and self-management intervention has been shown to reduce unplanned dependence on healthcare professionals and an overall reduction in cost [7]. Overall, the PR programs generate end results equivalent to usual care, but programs containing > or = 3 components show lower relative risks for hospitalization and healthcare resource utilization [8–10] in both young and elderly patients [11]. In a cost utility study based on a 6-week program, each rehabilitation program for up to 20 patients cost 12,120 GBP. The incremental utility of adding rehabilitation was shown to be significant but very small at 0.03 (95% CI 0.002 to 0.058) quality-adjusted life years (QALYs) per patient [12]. Thus, there appears to be limited scope for programs to break even or save money [13].

Studies describing the economic impact of COPD may have limitations, as costs based on results of a clinical trial are

likely to be significantly different from real-world practice. Sometimes, it may be more useful to capture the costs of the important components accurately rather than the often unachievable aim of capturing every cost however small. Burden of illness studies can help identify clinical targets or patterns of care—for example, hospitalization—which are major health care cost drivers. We designed a study assessing the cost of illness for patients participating in a PR program in the year before and after their participation.

2. Study Design and Methods

All patients who participated in a hospital outpatient-based 8-week, (16 visit) multi-component PR program were recruited in the study. We examined cost of illness, based on medication use, hospital admissions, hospital emergency room visits, and visits to general practitioners for 12 months before and 12 months after participation in the PR program. During the PR program, we measured spirometry, 6 MWD, endurance shuttle walk test (ESWT), St George's Respiratory Questionnaire (SGRQ), and Short Form 12 (SF-12) at baseline and on conclusion of the program.

The hospital-based PR program was composed of (1) education on clinical features, signs and symptoms, pathophysiology, complications, identification of exacerbations, pharmacology of essential medications and self-management plans for monitoring, and early institution of therapy for exacerbations; (2) question and answer session with a consultant respiratory physician; (3) dietary information and advice; (4) group support from a psychologist; (5) social worker advice on money, social benefits, and disability living allowance; (6) pharmacological advice on risks and benefits from using different core medicinal classes; (7) inhaler technique and when to initiate treatment for exacerbations; (8) graded exercise with individual needs and group activity [14]. This was run by 2 respiratory specialist physiotherapists, a physiotherapy/sports technician, a pharmacist, a dietician, a psychologist, a respiratory specialist nurse, and a consultant respiratory physician.

Each of the 16 visits to the hospital-based physiotherapy gymnasium included a 1-hour education session followed by a 1-hour supervised exercise session with additional sessions for assessments before and after the 8-week program. Patients were encouraged to maintain a home-based exercise and activity program for at least 3 days per week. There were 8–16 patients in each group. On conclusion of the PR program, patients were encouraged to book into refresher sessions, which were offered on a session/month basis, and participation to this session was "optional" and by patient choice only.

An intention to treat analysis method was used to deal with any dropouts from the program. Data was collected by access to patient records both in hospital and with their general practitioners. All cost data were calculated from published Department of Health NHS approved tariffs with cost year 2008. All medication cost was based on unit costs as listed in the British National Formulary for September 2008.

Cost of provision of pulmonary rehabilitation services was calculated from average NHS tariff based on reference costs from 2007/2008 at £232 per person per assessment. Based on a minimum of 8–16 patients per course and at least 4 multidisciplinary specialists being involved for 2 assessments +14 follow-up hospital visits, we calculated a range from £522 to £1044 as the average cost per person per course based on 8–16 participants.

We decided not to include informal or indirect costs and worked purely from real-life reported NHS reference costs, which include estates, overheads, and all ancillary service costs incurred in the provision of services.

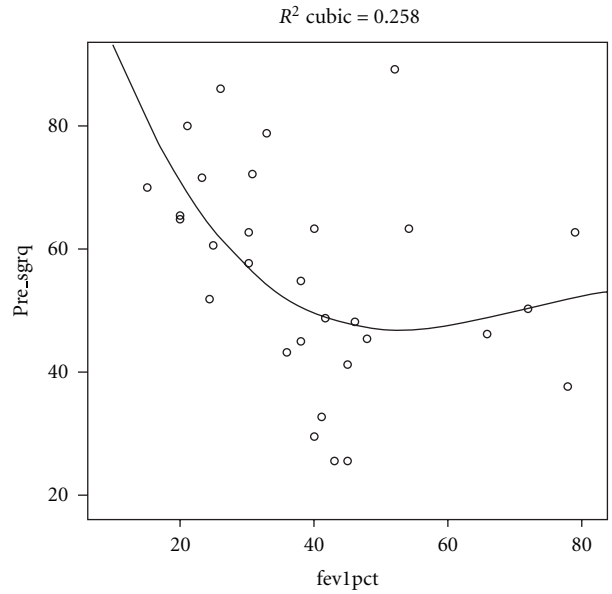

Figure 1: Scatter plot demonstrating the relationship between lung function and SGRQ total scores, with cubic regression analysis.

3. Results

There were 31 patients (female = 16) with a mean age of 68 (±8) years in the program, and patients were their own controls. Mean FEV_1% predicted was 40 (±16.6). Based on GOLD classification stages [16], there were the following proportions of patients in each stage: II = 6 (19.4%), III = 15 (48.4%), and IV = 10 (32.2%).

Lung function (*FEV_1% predicted*) at baseline was not related to baseline exercise capacity but negatively correlated with baseline SGRQ total scores (*Pearson's correlation coefficient* −0.351, $P = 0.05$). SGRQ total scores at baseline were however correlated with ISWT distance (*Pearson's correlation coefficient* −0.497, $P = 0.005$), Figure 1. ESWT time was not related with any parameters of lung function or ISWT distance walked.

There was a significant improvement in ISWT distance walked ($\delta =$ 40 m (27%), $P = 0.002$), ESWT time achieved ($\delta =$ 3.11 minutes (45%), $P = 0.002$), and HRQL (*SGRQ* total scores ($\delta = -8$ (15%), $P = 0.001$) after completion of the 8-week PR program as shown in Table 2 (see also Figure 2).

Inpatient hospital stay (bed days) dropped significantly by mean 2.35 days (78%; $P = 0.027$) per patient from

Table 1: National tariffs for the NHS in COPD-related admissions.

Code	Description	National average	Lower quartile	Higher quartile
DZ21A	COPD with length of stay 1 day or less discharged home	£319	£249	£374
DZ21B	COPD with intubation with major CC	£610	£162	£1,024
DZ21C	COPD with intubation with CC	£600	£282	£657
DZ21D	COPD with intubation without CC	£1,459	£334	£2,584
DZ21E	COPD with NIV without intubation with major CC	£427	£450	£450
DZ21F	COPD with NIV without intubation with CC	£378	£248	£450
DZ21G	COPD with NIV without intubation without CC	£383	£245	£547
DZ21H	COPD without NIV without intubation with major CC	£334	£239	£355
DZ21J	COPD without NIV without intubation with CC	£359	£245	£430
DZ21K	COPD without NIV without intubation without CC	£296	£224	£323
	Community Specialist Nursing (Asthma/COPD) visit	£76	£48	£88
	Community Medical Service (GPwSI/Comm. Specialist Clinic)	£193	£99	£345
	Consultant Respiratory Clinic First Attendance	£186	£142	£229
	Consultant Respiratory Clinic Followup	£118	£89	£136
	Multidisciplinary Rehabilitation service (Level 2) OP	£232	£258	£258
	Multidisciplinary Rehabilitation service (Level 2) OP FU	£116		

See [15].

Table 2: Paired Samples Statistics. This table shows the changes in inpatient days, GP visits, medication costs, exercise parameters, and HRQL after PR.

		Mean	*N*	Std. deviation	*P*
Pair 1	IP days	3.03	31	5.4	
	pst_ip days	.68	31	2.0	0.027
Pair 2	medic_cost	495.04	29	913.6	
	pst_med_cost	141.37	29	424.5	0.063
Pair 3	gp_cost	725.73	31	297.9	
	pst_gp_cost	776.02	31	378.8	0.193
Pair 4	pre_iswt	250.7	30	13.6	
	post_iswt	291.0	30	13.0	0.002
Pair 5	pre_eswt	6.89	27	4.2	
	pst_eswt	9.26	27	6.1	0.067
Pair 6	pre_sgrq	55.18	31	17.6	
	pst_sgrq	48.71	31	17.3	0.003

baseline. Routine visits to GP or nurse-led clinics dropped from 4.3 (±2.1) to 3.5 (±2.3) per patient per year, $P = 0.073$. Emergency visits to GPs remained the same at 2.7 (±1.8) in the year before and 2.8 (±2.2) in the year after PR, $P = NS$. Direct healthcare costs incurred in the primary care sector of visits to GPs or nurses and cost of medication prescribed dropped by a mean 353.7 GBP (71.4%, $P = 0.063$).

Hospital routine clinic appointments dropped from 2.6 (±2.3) to 1.7 (±1.5), $P = 0.026$. Aggregate direct inpatient healthcare costs per patient (based on NHS Reference costs 2007/2008 as in Table 1) dropped from GBP 1752.5 (±3276) to 372.7 (±1214.1), $P = 0.03$. Hospital total costs (inpatient and outpatient costs) were £2128.8 (±3319.6) down to £646.3 (±1233.5), $P = 0.022$.

The net saving in cost was £1835; thus, taking into account either £522/1044 as the cost of provision of PR program, the cost of PR program saved an average of £791 to 1313 GBP per person per year.

4. Discussion

Although home-based pulmonary rehabilitation programs may appear to be superior to center-based programs in terms of the adherence to exercise (especially in the long term) [17], overall, PR has been demonstrated to be efficacious in COPD, while its cost effectiveness remains largely unknown. One of the early studies in California reported back in 1983 that the number of days of hospitalization for the group given PR decreased from 497 in the year before completing the program to 34 in the year after [18], which was a substantial reduction. Almost 2 decades later, as the world faces a severe recession, and health care budgets including that of the NHS in the UK face major cuts, there is a new imperative to demonstrate continuing cost effectiveness of current components of healthcare provision. In this environment our study is able to report a significant reduction in health care resource utilization (HRU) primarily by means of reduced

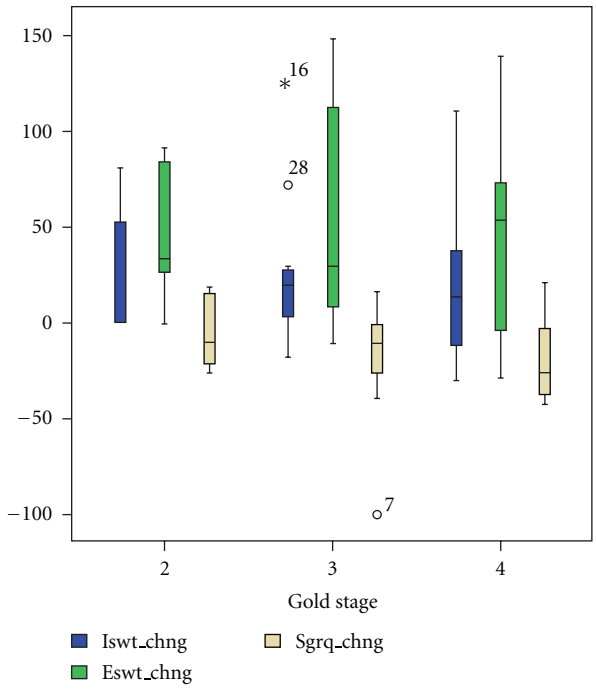

Figure 2: Depicting the change in exercise parameters and HRQL (SGRQ total scores) after pulmonary rehabilitation based on gold stages.

hospital admissions in the 12 months following participation in a pulmonary rehabilitation program compared to the previous 12-month period. Patients acted as their own controls, and although COPD being a progressive condition one may expect general condition to decline over time, our results indicate a reduction in hospital inpatient stay and hospital outpatient visits.

Observational research on HRU suggests that exacerbations in patients with moderate to severe COPD contribute largely to the cost burden. Amongst 691 acute exacerbations, which occurred in 53% of patients, seventy-five patients were admitted to hospital, with an average length of stay of 13 days with fourteen of the patients spending time in an intensive care unit (average length of stay 5.6 days) [19]. In the UK, burden of COPD studies suggest an annual cost of 781–1,154 GBP per patient [20].The results of the Canadian survey estimated the direct cost of the disease at approximately CA dollar 2000 per patient, with over half of this due to inpatient hospitalizations. COPD also had an impact on the economy, with indirect costs amounting to CA dollar 1200, a third of the total per patient cost of COPD to society (CA dollar 3200) [21].

Our data demonstrates that in a real-life, DGH setting, an outpatient-based, multi-component traditional PR program is able to show a significant direct healthcare cost saving even in a small number of patients, including the cost of provision of this service. There is a clear demonstration of improvement in HRQL and exercise tolerance in this group of patients after the 8-week program. The cost saving is manifest in a significant reduction in inpatient bed days, which often accounts for over half of the direct healthcare costs associated with COPD. There is also a small reduction in routine hospital and GP follow-up clinics. The medication cost, which is a small proportion of the total cost, remains the same.

Using a similar model, researchers determined that the health status of patients enrolled in the program improved significantly following PR, irrespective of the severity of disease (*total SGRQ score improved by* 4.85%). The average reduction of total costs before and after the program was approximately CANS $344 per person per year [9]. Using a similar population group (*mean age* 68 *years, FEV1* 44% *predicted*), a study in 10 centres in California reported significant improvement, although the benefits regressed over an 18-month followup [10]. An Australian study with 187 patients also showed improvements in 6MWD and HRQL following PR and reported a 46% reduction in the number of patients admitted to hospital with an exacerbation and a 62% reduction in total bed days following PR [22]. Griffiths et al. reported in 200 patients, mainly with COPD. (randomly assigned to 18 visits, 6-week rehabilitation program costing up to 606 GBP per patient), that a mean incremental cost of adding rehabilitation to standard care was −152 GBP (95% CI 2212881 to 577), although this did not reach statistical significance. The incremental utility of adding rehabilitation was 0.03 QALYs per patient [12]. We estimated the cost of PR provision based on NHS Reference costs to be between 522 and 1044 GBP per person per program, which was in the same range as that of Griffiths et al., and including this cost in our calculations we estimated the savings per person per year to be 791–1313 GBP simply in health care resource utilisation.

Even in a small rural hospital setting, PR provision has demonstrated significant reductions in cumulative acute hospital care utilization indicators (95% emergency department presentations, 95% inpatient admissions, 99% length of stay) 12 months after the introduction of the PR program; in contrast, changes in the cumulative indicators were statistically insignificant for the control group [23].

A multi-component PR program includes elements of education and exercise combined with support and counseling in other aspects such as dietary, pharmaceutical, social, and psychological support. In addition to exercise, there is emerging evidence that disease management with self-management education provided by a case manager also benefits COPD patients [24].

We found that the majority of the cost saving was achieved through reduction in hospital (including ICU) stay and visits to primary care providers. Similar results were reported from a large study in USA, where most of the reduction in hospital utilization was due to a decrease in intensive care unit days and the number of physician visits (decreased by 2.4) in the year after PR. The estimated costs/charges for the aspects of healthcare utilization that were studied decreased by a mean of 4.694 US dollars and a median of 390 US dollars [25].

Current research shows that, unlike a hospital-based formal program, an intermediate care package incorporating PR, self-management education, and the receipt of a written

COPD action plan, together with regular nurse contact, is associated with a reduced need for unscheduled primary care consultations and a reduction in deaths due to COPD but does not affect the hospital readmission rate [26]. In addition to showing a significant decrease in number of hospitalizations and length of stay following attendance at the program, researchers have also reported that 72% of the subjects are likely to continue to carry out an exercise routine [8]. Often persistence with exercise program initiated at a formal hospital-based program may be difficult due to psychosocial dysfunction that is often reported in chronic disease patients especially when these programs require lifestyle modification. Community-based programs may therefore be attractive for reasons such as addressing the specific needs of the population, cost benefit, and flexibility in delivery [27]. Others have shown that the results are preserved over a longer period of time even without a maintenance element [28].

Our study does not take into account indirect costs of healthcare and the impact of the burden of disease to next of kin, loss of earning, and provision of social care and to society in general. Our study was designed specifically to answer the question of our primary care commissioners of the cost effectiveness of PR program in reduction in direct healthcare utilization measured by reduction in hospital admissions and access to primary care provision. We also deliberately chose NHS reference costs rather than locally acquired costs in order to allow for generalizability of our data to other hospitals and primary care groups or trusts in the UK. Therefore, our cost savings based on real costs balanced against the cost of PR provision may help to justify and support improved PR provision to COPD patients in the current recession.

5. Conclusion

COPD is a common, preventable disease that affects a significant number of people. It may be managed by utilizing various readily available medical therapies, as well as other nonpharmacologic interventions, such as pulmonary rehabilitation. Proper coordination of care are important, as are efforts focused on improving quality of life and reduction of symptoms [29]. As shown in our study, it is established that, in COPD patients who complete PR program, outpatient training results in significant and clinically relevant changes in 6MWD, ESWT, peripheral and respiratory muscle strength, and quality of life as demonstrated in our cohort [4]. Identifying cost-effective, multi-component COPD programs remains a challenge due to scarce methodologically sound studies that demonstrate significant improvements on process, intermediate, and end results of care. Estimations of potential real-life cost effectiveness of specific PR programs illustrated in this study can, in the absence of "perfect data", support timely decision-making regarding these programs. Well-designed health economic studies are still needed to decrease the current decision uncertainty. Pulmonary rehabilitation delivered in a community setting has similar efficacy to that produced in a more traditional hospital-based setting, both settings producing significant improvements in terms of exercise capacity and quality of life acutely and after long-term followup. The choice of model will depend on local factors of convenience, existing availability of resources, and incremental costs [30]. Simultaneously, there is an increasing policy emphasis on patient choice and individualized care in the NHS [31].

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