

A Budget Impact Analysis of Bronchial Thermoplasty for Severe Asthma in Clinical Practice

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ABSTRACT

Introduction: Fully 80% of asthma-related deaths occur in patients with uncontrolled disease and 50% of all costs are attributable to this subgroup. Although asthma is costly, direct costs and loss of productivity have only recently been extensively studied, partly as a result of the introduction of new and more costly treatment options. A 5-year population-based budget impact model in the perspective of the Emilia Romagna of Italy regional healthcare service compared the impact of adding adjuvant bronchial thermoplasty (BT) for a population of patients with severe, uncontrolled asthma treated with standard care (SC) with or without adjuvant omalizumab (OMAL).

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Methods: The model compared the budget impact of two scenarios: the first examined a population treated either with SC alone or with administration of OMAL concurrent to SC; the second examined a population treated either with SC alone or with either the concurrent administration of OMAL or BT.

Results: The cost for treating asthmatics patients in Emilia Romagna with BT would require 17.7 million Euros during the initial year; these costs would be offset by savings of 1 million Euros, 10.5 million Euros, and up to 19.2 million Euros during third, fourth, and fifth years, respectively.

Conclusion: Despite the increase in direct costs, the complementary treatment of patients with either BT or OMAL in addition to SC may not only help the clinician to meet the needs of a greater number of patients, but also decreases emergency room visits and hospitalizations, as well as generates economic savings in the longer term.

Keywords: Bronchial thermoplasty, Budget impact; Costs; Omalizumab; Respiratory; Severe asthma

INTRODUCTION

In spite of many therapeutic approaches for asthma, some patients experience difficulty controlling asthma. Fully 80% of asthma-related deaths occur in patients with uncontrolled disease and 50% of all costs are attributable to this subgroup [1]. Persistent asthma costs increase drastically as control of the disease decreases [2]. Although asthma is costly, direct costs and loss of productivity have only recently been extensively studied, partly as a result of the introduction of new and more costly treatment options, resulting in an increase in direct treatment costs and a greater attention to the economics of asthma therapy [1].

One new therapy is omalizumab (OMAL), for which there are now several studies suggesting that this drug is both clinically and cost-effective over longer time periods [3–5] when prescribed and administered to a select group of patients with poorly controlled, severe asthma.

A new alternative to pharmacological treatment is bronchial thermoplasty (BT), a procedure which applies mild heat to the airways, reducing excessive smooth muscle. Contraction of this excessive smooth muscle is the main cause of airway constriction that leads to difficulty in breathing during asthma attacks. BT has been shown to offer long-term clinical effectiveness out to 5 years [6, 7], suggesting that this procedure can result in durable benefits that may translate into economic savings.

While the clinical benefit of BT has been demonstrated [6, 7], the budgetary impact of the incorporation of BT to clinical practice is an as of yet unresolved question. In this analysis, we developed an economic model comparing the impact of introducing BT in the clinical practice by shifting a proportion of the

population from standard care (SC) and SC concomitant with OMAL (SC + OMAL) to SC concomitant with either BT or OMAL.

METHODS

We developed a budget impact analysis on an Excel spreadsheet (Microsoft® Excel® 2010 version 14.0, Microsoft Corporation, Redmond, WA, USA) to project the costs of a hypothetical cohort of adult patients affected by severe, uncontrolled asthma. The model represents two scenarios: the first considers SC alone and SC with the administration of OMAL; the second considers making available the BT procedure to a subset of patients. Both scenarios estimate resource consumption and savings over 5 years. The model provides a comparison of expected costs for each treatment option based on differences in resource utilization. For the model, we adopted the perspective of a third-party payer within the Emilia Romagna region of Italy.

Average costs are expressed as cost per patient per year, cost per patient cumulatively, and budget impact costs (i.e., cost of a cohort of patients on a mix of therapies).

The reference population was estimated on the basis of available data from Istituto nazionale di STATistica [8] and updated literature sources. The mix of treatments followed the clinical indications of the Global Initiative for Asthma (GINA) guidelines [9], which describe OMAL to be indicated in adults with moderate-to-severe persistent asthma who have a positive skin prick test or in vitro reactivity to a perennial aeroallergen and whose symptoms are inadequately controlled with inhaled corticosteroids, whereas for BT, which recently accessed the market, a clear place in therapy has not been strictly established yet [9, 10]. The model supposed

that, in the first scenario a population mix was constituted by 80% of subjects on SC and 20% on SC + OMAL. According to the literature data, in OMAL-treated patients, 61% were identified as responders to treatment by physician's overall assessment [10]. In the second scenario, when introducing BT, the model conservatively considered the shift of 40% of non-respondent OMAL patients to BT, plus 5% of SC patients. This 5% primarily represents standard of care patients that still need another option and are contraindicated for OMAL.

Direct costs per year, including maintenance medications, scheduled and unscheduled physician visits, and hospitalizations and emergency room (ER) admissions were estimated based on the established literature and, where not available, estimates were provided by an expert clinicians' panel from the Hospital of Reggio Emilia (Italy). Costs reported in this analysis represent 2013 Euros.

Based on clinical data, we conservatively assumed that among patients treated with either BT or OMAL, maintenance medications usage would not reduce, relative to SC. Use and adherence to maintenance medications were based on rates observed within a recent clinical trial that examined BT [7].

Resource consumption related to ER visits, hospitalizations, and specialist visits due to asthma exacerbation changed in the model and reflects the efficacy of treatments with OMAL or BT; these rates reflect clinical data and data from the established literature [7, 11]. Values for resource consumption in the SC population were retrieved from the established literature and indicated that patients with severe asthma access ER 1.41 times are hospitalized 0.46 times and visit a specialist's ambulatory clinic 4.7 times per patient per year [12].

Similarly, the short-term risk of adverse events was incorporated into the model using clinical trial data [7], i.e., a 3.4% risk of a severe adverse event was assigned to each BT procedure. The associated hospitalizations, ER, and physician visits and their costs are included in the model results.

Medication costs were based on the average daily dose and retail prices for the Emilia-Romagna region of Italy [13, 14]. In accordance with clinical practice and the literature, the model assumed that 75% of patients are getting one injection per month and 25% get two injections per month [6]. The number of BT treatments was considered a fixed value of three sessions per patient, all occurring within the first year.

BT procedure, specialist visit and ER admission costs were estimated with a micro-costing technique: resource consumption and unit full costs were provided by the Hospital of Reggio Emilia.

The robustness of the model was assessed with the implementation of several sensitivity analysis.

RESULTS

We estimated that 18,146 adults are affected by uncontrolled, severe asthma in the Emilia-Romagna region. When introducing BT in the clinical practice, by shifting 40% of potential OMAL non-respondent patients (namely, 566 patients) plus 5% of patients treated with SC (726 patients), we estimated that 1,292 subjects can be treated with BT. Details of data inputs are reported in Table 1.

In terms of cumulative per patient costs, both OMAL and BT are add-on therapies to SC. During the first year of treatment, BT procedure adds approximately 20,000 Euros to SC.

Table 1 Model inputs

Target population		Source
Emilia-Romagna Region inhabitants, December 2012	4,341,240	[8]
Adults >18 years in Emilia-Romagna, December 2012	3,652,556	
Rate of adults affected by asthma	6%	[9]
Rate of adults affected by severe asthma	15%	
Rate of uncontrolled asthma among those with severe asthma	55.2%	[2]
Estimated target population	18,146	
Population in the first scenario		Population in the second scenario
	No. of patients	%
BT	0	0
SC	14,517	80
OMAL	3,629	20
Total	18,146	100
Asthma medications		Adherence (%)
	Patients (%)	
Short-acting β_2 agonist	100	100
Long-acting β_2 agonist	0	100
Inhaled steroids	5	100
Fixed-dose combination	100	100
Leukotriene agonist	30	100
Unit cost		Source
	Euros	
SC ^a	2,087	Estimation
OMAL treatment ^b	15,150	Hospital Reggio
BT procedure ^c	6,550	Emilia estimation
ER visits ^d	140.48	Hospital Reggio

Table 1 continued

Unit cost	Euros	Source
Specialist visits ^c	98.63	Emilia estimation [4]
Hospitalizations	2,158	
<i>BBT</i> bronchial thermoplasty, <i>ER</i> emergency room, <i>OMAL</i> omalizumab, <i>SC</i> standard care		
^a 1 year cost of treatment, including €1,153 (55%) for drugs cost and remaining €1,164 (45%) exacerbations management costs		
^b 1 year cost of OMAL, including €37.45 per average daily dose, plus 1.25 administration per month		
^c The average full procedure cost was estimated including 1-h operating room workload of three pulmonologists and three nurses, admissions in pulmonology ward and intensive wards (length of stay = 3 days, respectively); retail price of BT catheter VAT included (4%)		
^d ER visit for asthma exacerbation included 30-min workload of 2 specialist and nurse, test and drugs for respiratory emergency, plus 19% overhead costs		
^e Pulmonologist visit for asthma exacerbation was estimated considering 30-min time visit plus respiratory tests		

However, in future years, since BT is a one-time procedure, the cumulative costs decreased by introducing BT to the population. The cumulative costs per patient and the cost per patient per year are reported in Table 2: the cost per patient per year clearly showed that the introduction of BT increased costs of treating patients only for the first year; other costs decrease strongly in the following years, generating net savings.

In terms of resource consumption, savings when introducing BT were clear during the third year and thereafter. BT reduced ER visits and hospitalizations related to asthma exacerbations in comparison to SC. BT reduced the rate of ER utilization by 83.3% and reduced the rate of hospitalization by 74.2%.

For the Emilia-Romagna region, the cost for introducing BT to this cohort of 1,292 patients affected by severe, uncontrolled asthma would require about 17.7 million Euros during the first year, but these costs would be offset by savings from avoided adverse events. BT would produce savings of approximately 1 million Euros after year three, 10.5 million Euros after year four, and up to 19.2 million Euros after year five—by which time all the initial cost of introducing BT in the clinical practice would be covered and would generate a net savings to the regional healthcare system (see Fig. 1).

Sensitivity Analysis

A Number of Univariate Sensitivity Analyses were Performed

We identified that the impact to the budget of hospitals in the region was sensitive to variation in the proportion of the population treated with BT. When shifting only 30% of OMAL non-responders to BT procedure, cumulative savings begin after the fourth year (approximately 2.5 million Euros), increasing after the fifth year to

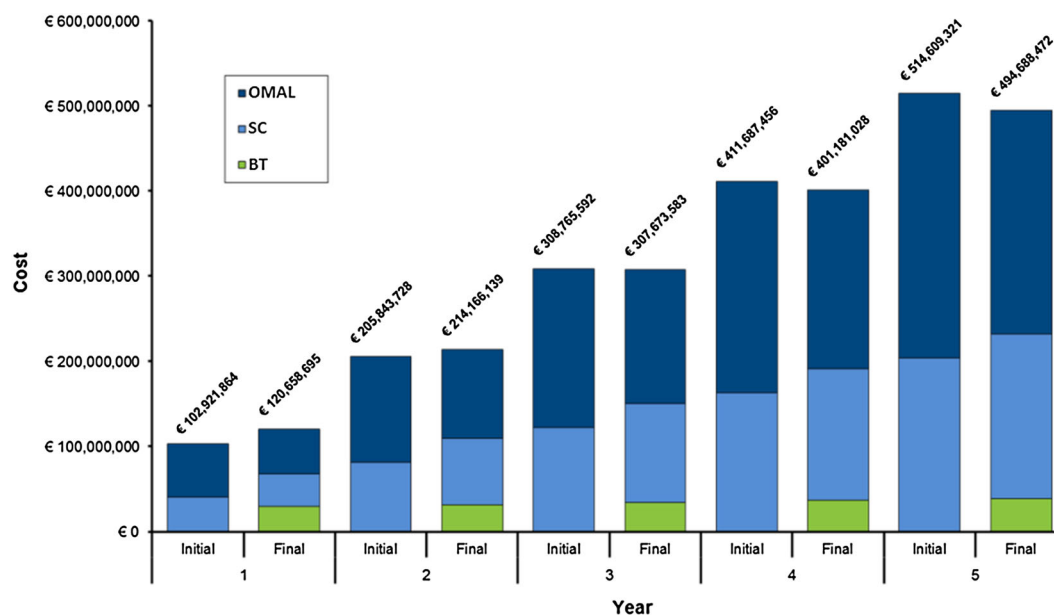


Fig. 1 Basecase budget impact: cumulative total cost of asthma therapy before and after BT introduction—Emilia-Romagna region perspective. *BT* bronchial thermoplasty, *OMAL* omalizumab

approximately 9.1 million Euros with an initial cost of about 17 million Euros.

Savings were greater when introducing a greater proportion of patients to BT procedure. In an alternative Scenario 2, we shifted 50% of OMAL non-responders to BT procedure (see Table 3): this shift produced savings after the third year (approximately 4.6 million Euros) up to about 27.8 million Euros after the fifth year, in spite of the increased initial cost from a greater proportion of patients treated with BT (see Table 3).

Some sources report prevalence of severe asthma in the range of 5% [12, 15]. When applying this rate to the number of patients affected by asthma, the initial investment is obviously reduced while savings, already evident at third year, became higher than initial investment at fifth year (Table 3).

The cost of procedure was estimated only for one regional hospital; therefore, a sensitivity analysis of $\pm 20\%$ on the procedure cost was performed. If the procedure cost was higher,

savings were shown at year four instead of year three with net savings after year five approximately 90% those of the basecase; decreasing the cost of procedure by 20% resulted in higher savings than in the basecase (Table 3).

Furthermore, we investigated the robustness of a series of parameters which demonstrated only minor impact on the results (Table 3). When valuing the cost of admission according to regional tariffs (€4,810) rather than according to real hospital practice (€2,158), savings remained evident by the third year and the 5-year saving was approximately 22 million Euros, against 18.9 million Euros for the implementation of the procedure. Changing the rates of resource consumption to values reported from other literature sources [1, 16] as well as variations in the rates of SC medications use did not significantly impact the shorter-term savings, but changed longer-term savings (Table 3).

Finally, we considered expanding the examined population to the Italian National

Table 2 Basecase results

Therapy	Year 1			Year 2			Year 3			Year 4			Year 5		
	BT	SC	OMAL	BT	SC	OMAL	BT	SC	OMAL	BT	SC	OMAL	BT	SC	OMAL
Asthma total costs per patient per treatment															
Treatment	€ 19,650	€ 0	€ 15,150	€ 0	€ 0	€ 15,150	€ 0	€ 0	€ 15,150	€ 0	€ 0	€ 15,150	€ 0	€ 0	€ 15,150
Maintenance medications	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153	€ 1,153
Physician visits	€ 452	€ 464	€ 263	€ 355	€ 464	€ 263	€ 355	€ 464	€ 263	€ 355	€ 464	€ 263	€ 355	€ 464	€ 263
Emergency access	€ 60	€ 198	€ 79	€ 33	€ 198	€ 79	€ 33	€ 198	€ 79	€ 33	€ 198	€ 79	€ 33	€ 198	€ 79
Hospitalization	€ 1,497	€ 993	€ 485	€ 256	€ 993	€ 485	€ 256	€ 993	€ 485	€ 256	€ 993	€ 485	€ 256	€ 993	€ 485
Total	€ 22,812	€ 2,807	€ 17,130	€ 1,797	€ 2,807	€ 17,130	€ 1,797	€ 2,807	€ 17,130	€ 1,797	€ 2,807	€ 17,130	€ 1,797	€ 2,807	€ 17,130
Asthma cumulative costs per patient per treatment															
Treatment (BT)	€ 19,650	€ 0	€ 0	€ 19,650	€ 0	€ 0	€ 19,650	€ 0	€ 0	€ 19,650	€ 0	€ 0	€ 19,650	€ 0	€ 0
Treatment (OMAL)	€ 0	€ 0	€ 15,150	€ 0	€ 0	€ 30,299	€ 0	€ 0	€ 45,449	€ 0	€ 0	€ 60,599	€ 0	€ 0	€ 75,749
Maintenance medications	€ 1,153	€ 1,153	€ 1,153	€ 2,306	€ 2,306	€ 2,306	€ 3,459	€ 3,459	€ 3,459	€ 4,612	€ 4,612	€ 4,612	€ 5,765	€ 5,765	€ 5,765
Physician visits	€ 452	€ 464	€ 263	€ 807	€ 927	€ 527	€ 1,161	€ 1,391	€ 790	€ 1,516	€ 1,854	€ 1,053	€ 1,871	€ 2,318	€ 1,317
Emergency access	€ 60	€ 198	€ 79	€ 93	€ 396	€ 157	€ 126	€ 594	€ 236	€ 159	€ 792	€ 315	€ 192	€ 990	€ 393
Hospitalization	€ 1,497	€ 993	€ 485	€ 1,753	€ 1,985	€ 971	€ 2,009	€ 2,978	€ 1,456	€ 2,265	€ 3,971	€ 1,942	€ 2,521	€ 4,963	€ 2,427
Total	€ 22,812	€ 2,807	€ 17,130	€ 24,609	€ 5,615	€ 34,260	€ 26,406	€ 8,422	€ 51,390	€ 28,203	€ 11,229	€ 68,520	€ 29,999	€ 14,037	€ 85,651

BT bronchial thermoplasty, OMAL omalizumab, SC standard care

Table 3 Sensitivity analysis

Resource savings	No. of specialist visits	No. of emergency access	No. of hospitalizations	1-year investment if introducing BT (million Euros)	Resource savings at 3 years (million Euros)	Resource savings at 5 years (million Euros)
BT target population ($N = 18,146$)						
Basecase—Scenario 1: BT 0%; SC 80%; OMAL 20%	4.7	1.41	0.46	17.70	1.00	19.20
Scenario 2: BT 7.12%; SC 76.00%; OMAL 16.88%						
Scenario 1: BT 0%; SC 80%; OMAL 20%						
Alternative Scenario 2: BT 7.90%; SC 76.00%; OMAL 16.10%				18.54	4.60	27.80
Prevalence of severe asthma patients						
Basecase—15% of asthma patients	4.7	1.41	0.46	17.70	1.00	19.20
Alternative scenario—5% of asthma patients				5.90	0.360	6.64
BT procedure cost						
Basecase—€3,430	4.7	1.41	0.46	17.70	1.00	19.20
+20% on the procedure cost				20.40	7.8 at 4th year	17.20
–20% on the procedure cost				15.08	3.75	22.60
Hospitalization costs						
Basecase—€2,158	4.7	1.41	0.46	17.70	1.00	19.20
Assumption from diagnosis-related group tariffs—€4,180	4.7	1.41	0.46	18.90	1.57	22.03
Resource consumption						

Table 3 continued

Resource savings	No. of specialist visits	No. of emergency access	No. of hospitalizations	1-year investment if introducing BT (million Euros)	Resource savings at 3 years (million Euros)	Resource savings at 5 years (million Euros)
Basecase [12]	4.7	1.41	0.46	17.70	1.00	19.20
Variation #1 [16]	2.06	0.69	0.94	18.70	1.30	21.30
Variation #2 [2]	2.50	0.20	0.30	17.50	0.60	18.70
Variation in the rate of SC medication use						
Use of oral steroids—Basecase 0%	4.7	1.41	0.46	17.70	1.00	19.20
Use of oral steroids—Assumption 100%	4.7	1.41	0.46	17.90	0.86	19.69

BT bronchial thermoplasty, OMAL omalizumab, SC standard care

Health Care System for the Italian Republic, estimated to be 17,473 patients. For this population, the introduction of the BT procedure would imply an initial additional cost of approximately 234 million Euros, with a 3-year saving of about 31 million Euros and a long-term saving estimated to be approximately 297 million Euros.

DISCUSSION

This work represented, to our knowledge, the first effort to estimate the economic effect of introducing the BT procedure to severe, uncontrolled asthma patients. This work helps provide payers with needed information how the introduction of BT may modify the economic and clinical expectations of a hypothetical cohort of these patients.

Although BT was associated with high costs at the time of the procedure, savings for the regional healthcare system were evident in the most conservative hypothesis—when shifting the potential 40% of OMAL non-respondent patients and 5% of SC patients to the BT procedure. This shift is estimated to result in long-term reductions in ER visits and hospitalizations.

Within this model, we did not consider dynamic changes to the population eligible for BT. This emergent technology may find greater or lesser adoption than that presented in this model. This represented a limit of the estimation, as the BT population was one of the sensitivity variables in the budget impact analysis; increased patients considered non-responders to OMAL fosters greater savings for the Emilia-Romagna region. Similarly, the model assumes that the full subsequent-year savings are available to the same health care system as that system investing in the BT procedure in year one. Patients dynamically

moving into and out of various regions' health care system could create a situation in which the savings are realized for a different entity than that system investing in BT.

As for the composition of the population treated with BT, we chose to include the very severe patients with uncontrolled asthma, namely, the ones with forced expiratory volume in the 1st second (FEV1) lower than 60% and the ones who experienced exacerbations. Although BT indications do not exclude these types of patients, the results of this analysis could change based on the inclusion or exclusion of these cases. The lack of a precise definition of the amount of patients with such clinical conditions in the current literature did not allow us to perform a specific analysis.

It is also important to note that we have considered eligible for BT treatment those patients with severe non-allergic asthma who are non-responders to OMAL, though patients with severe allergic asthma inadequately controlled by standard care may be considered for the BT procedure prior to OMAL non-response. A small rate of patients in treatment on SC could be shifted to BT due to contraindication to pharmaceutical treatment, physician preference for procedure and patient preference for procedure instead of pharmaceutical treatment.

Finally, it is important to reiterate that BT and OMAL are complementary methods of treating severe asthma. These two treatments, when considered together, afford the treating physician greater choice of treatment and flexibility to choose the right treatment for the individual patient. Together, allowing the physician to better meet the clinical needs of a greater number of patients afflicted with uncontrolled, severe asthma.

CONCLUSION

Although the initial cost of BT appears costly, health care decision makers should consider both initial costs and downstream savings when evaluating new, novel pharmaceuticals and medical technologies. While it is difficult to assess the exact cost of BT based on its relative infancy as a therapeutic procedure, this model serves as important data point for these decision makers.

In this present analysis, we have shown benefits beyond clinical flexibility to treat asthma patients—namely, potential economic benefits to the Emilia-Romagna region's health care system. In spite of initial upfront costs, we estimate that the introduction of BT to the region's healthcare system realizes cost savings within a few years. The overall impact of the introduction of BT to the severe asthma population who remain not well controlled is positive.

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Compliance with ethics guidelines. This article does not contain any new studies with human or animal subjects performed by any of the authors.

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