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Julie Burn, Andrew J. Sims, Kim Keltie, Hannah Patrick, Sally A. Welham, Liam G. Heaney, and Robert M. Niven

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ABSTRACT

Objective: Bronchial thermoplasty (BT) is a novel treatment for severe asthma. Its mode of action and ideal target patient group remain poorly defined, though clinical trials provided some evidence on efficacy and safety. This study presents procedural and short-term safety evidence from routine UK clinical practice. Methods: Patient characteristics and safety outcomes (procedural complications, 30-day readmission and accident and emergency (A&E) attendance, length of stay) were assessed using two independent data sources, the British Thoracic Society UK Difficult Asthma Registry (DAR) and Hospital Episodes Statistics (HES) database. A matched cohort (with records in both) was used to estimate safety outcome event rates and compare them with clinical trials. Results: Between June 2011 and January 2015, 215 procedure records (83 patients; 68 treated in England) were available from DAR and 203 (85 patients) from HES. 152 procedures matched (59 patients; 6 centres), and of these, 11.2% reported a procedural complication, 11.8% resulted in emergency respiratory readmission, 0.7% in respiratory A&E attendance within 30 days (20.4% had at least one event) and 46.1% involved a post-procedure stay. Compared with published clinical trials which found lower hospitalisation rates, BT patients in routine clinical practice were, on average, older, had worse baseline lung function and asthma quality of life. Conclusions: A higher proportion of patients experienced adverse events compared with clinical trials. The greater severity of disease amongst patients treated in clinical practice may explain the observed rate of post-procedural stay and readmission. Study of long-term safety and efficacy requires continuing data collection.

Introduction

Bronchial thermoplasty (BT) is a novel treatment for severe asthma. Thermal energy is applied to the airway wall to reduce excessive bronchial smooth muscle, limiting its ability to contract and narrow the airway. It is normally delivered in three bronchoscopic procedures, approximately 3–4 weeks apart.

Clinical trials [1–3] have provided some evidence to support the efficacy and short-term safety of BT and 5-year safety data has also been published [4–6]. However two of the trials were performed in patients with moderate to severe asthma and only one of these trials had a sham control arm. More evidence is required to confirm the long-term benefits of BT [7,8] and several studies call for further investigation to understand the mode of action and to define the subtypes who would benefit the most [9–11]. There has been little information published to date about the safety of BT in routine clinical practice in people with more severe asthma than those who took part in the trials. A case series of 8 patients [12] and another of 4 patients [13] demonstrated safety of BT in more severe asthmatics. In addition, a study of 10 patients in a centre which previously took part in the trials did not find any safety concerns at 12 months post-procedure [14]. Adverse events reported to be related to BT have included lung abscess [15], recurrent lung atelectasis [16] and lobar consolidation and ground glass opacities [17].

Although BT may have potential as a promising treatment for severe asthmatics, a Cochrane Review in 2014 [18] concluded that the overall quality of evidence...
for the procedure is ‘moderate’ and recommended the systematic collection of data in an independent clinical registry. International guidelines on the treatment of severe asthma [19] stated that BT should only be performed in the context of an Institutional Review Board approved independent systematic registry or a clinical study, due to the low confidence in reported evidence. Prior to these recommendations, in 2012 in the UK, the National Institute for Health and Care Excellence (NICE) reviewed BT [20] concluding that published evidence showed some short-term improvement in symptoms and quality of life, reduced exacerbations and admissions to hospital, but more evidence was required on long-term safety. NICE recommended the collection of safety and efficacy outcomes through the British Thoracic Society (BTS) UK Difficult Asthma Registry [21] (DAR) and their guidance instructs clinicians to submit details of all patients undergoing the BT procedure. DAR was established in 2006 to collect data about patients with difficult asthma and was subsequently expanded to collect data for BT. The safety and efficacy outcomes and the specific fields to be added to the registry pages were agreed through consultation with clinicians in the BTS Severe Asthma Network and supported by NICE (see online supplementary material). Guidance was issued to all centres undertaking BT regarding pre-treatment, follow-up and data collection in DAR to improve standardisation of patient care and achieve consistent data capture.

Routinely collected hospital administrative data may also provide a means of evaluating outcomes of procedures in routine clinical practice. Hospital Episode Statistics [22] (HES) is a data warehouse containing details of all admissions, outpatient appointments and accident and emergency (A&E) attendances at National Health Service (NHS) hospitals in England. Each episode of care contains coded procedure and diagnosis information allowing for identification of procedures of interest and occurrence of complications.

This study supports the recommendations of NICE Guidance [20], and also aligns with current international efforts to improve data collection outside of a clinical trial setting for new technologies [23, 24]. The aim of this paper is to present procedural and short-term safety evidence for BT using data collected during routine clinical practice in the UK. We used two independent data sources (DAR and HES) to assess selected safety outcomes including procedural complications, readmissions, A&E attendances and post-procedure stay. We also compared patient characteristics and safety outcomes with published trials. Preliminary results of this study were presented previously [25].

Methods

Data extraction

BT baseline, procedure and follow-up records in DAR on 31 January 2015 for patients having BT between June 2011 and January 2015 were extracted for analysis. In accordance with registry information governance requirements, the data were provided in anonymised form. Patients had previously given fully informed written consent for their information to be entered into DAR. Ethics approval for the registry was provided by the Office for Research Ethics Committees Northern Ireland (10/NIR02/37).

Records representing episodes of care in the period 1st April 2011 to 31st January 2015, which involved a BT procedure, were identified from HES. From these procedure episodes, a list of unique pseudonymised person identifiers was extracted and used in a second search of HES to extract all episodes of care, including readmissions and A&E attendances following BT procedures, to create a longitudinal record for each BT patient. A full description of the search and filtering criteria is included in the online supplementary material.

HES data are only applicable to England, but DAR also accepts data from Scotland, Wales and Northern Ireland. Total UK coverage of BT procedures in DAR was assessed by contacting the sole manufacturer of the BT device to confirm whether there had been any BT procedures carried out in UK centres which were not contributing data to DAR.

Patient characteristics

Age at first procedure and gender were retrieved from both sources; baseline asthma status, including pre-bronchodilator forced expiratory volume in 1 second (FEV₁) (% of predicted) and Asthma Quality of Life Questionnaire (AQLQ) score (a higher AQLQ score represents better quality of life) [26], was obtained from DAR only.

Comparison with data from previous clinical trials

Patient demographic data, lung function and asthma related quality of life (AQLQ) were compared with published clinical trials [1–3]. Safety outcomes including rates of procedural complications, readmissions and A&E attendances within 30 days were compared with reported hospitalisation rates for the three published clinical trials.

Identification of safety outcomes

BT procedures in DAR were reviewed for any events related to safety mentioned in any of the data fields, i.e. including, but not restricted to the free text ‘Unanticipated
Procedural Morbidity' field. The severity of the reported respiratory events, including mild reactions, unanticipated events and device problems, was reviewed at regular BT steering group meetings at which NICE, a NICE External Assessment Centre, the BTS and the respiratory clinicians were represented, to account for potential reporting bias.

Both DAR and HES were reviewed for four binary safety outcomes: procedural complications, post-procedure overnight stay, readmissions and A&E attendances within 30 days following the BT procedure. Using an anonymised matching technique, records in both sources were identified and referred to as the 'matched cohort'. This 'matched cohort' was used to count procedures which had an event reported in either DAR, HES or both, and hence to calculate combined safety outcomes. As BT is usually delivered in three treatments, the first (BT1), second (BT2) and third (BT3) procedures were analysed separately to look for any differences between them.

**HES—procedural complications**
In HES, a procedural complication was identified if the episode contained certain combinations of International Classification of Diseases (ICD-10) codes [27].

**HES—readmissions within 30 days**
These included any in-patient admission within 30 days of the BT procedure, ensuring that admissions for subsequent BT procedures that happened to fall within 30 days were excluded. The subset of potential emergency, respiratory readmissions was also identified using HES fields for admission method and diagnosis; the BT steering group reviewed the ICD-10 diagnoses codes to verify the reason for admission.

**HES—A&E attendances within 30 days**
These included any A&E attendance within 30 days of the BT procedure. The subset of respiratory A&E attendances which did not result in a hospital admission was also identified. This ensured that an A&E attendance which resulted in a hospital admission was not counted as two events.

**HES—post-procedure overnight stay**
Episodes that involved an overnight stay were identified if the date of discharge was after the date of procedure.

**DAR—procedural complications**
These included procedures with an entry in the 'Unanticipated Procedural Morbidity' field reporting a complication.

**DAR—readmissions within 30 days**
Several fields in DAR records were checked for the mention of readmission within 30 days including the fields for 'Any Hospital Admissions Since Last Treatment,' 'Unanticipated Procedural Morbidity' and 'Clinical Summary' (of the procedure and follow-up records).

**DAR—A&E attendances within 30 days**
As above, the same fields were checked for any mention of A&E attendance within 30 days.

**DAR—post-procedure overnight stay**
These included procedure records where the 'Duration of Admission' field was more than 24 hours.

**Matching DAR and HES records**
A combination of automatic and manual methods was used to match procedure records between DAR and HES. The criteria for matching between DAR and HES were: the treatment centre (hospital) and sex were required to match exactly, the HES procedure date and DAR procedure date were required to be within 2 days (or the DAR procedure date fell between the HES admission and discharge dates) and the difference in age was required to be no more than 1 year. Capture–recapture analysis [28] was used to obtain the maximum likelihood estimate of the true number of procedures undertaken and an estimated coverage for each data source (DAR and HES).

**Consideration of censored data**
In DAR, readmissions and A&E attendances following the final elective procedures (normally BT3) are usually reported at the six-month follow-up visit. If the final elective procedure was administered before 31 July 2014 (6 months prior to end of study period) and no six-month follow-up information was available, then the procedure was treated as having no reported readmissions or A&E attendances. If the final elective procedure was after 31 July 2014 and no follow-up record was available (e.g. follow-up appointment scheduled after the study end-date), the procedure was excluded from the analysis of readmissions and A&E attendances. In DAR and HES, BT procedures within 30 days of the study end-period were excluded from analysis.

**Statistics**
Fisher’s exact test was used to test for differences between the proportions of BT1, BT2 and BT3 procedures with a reported respiratory event (in DAR) and with a reported
complication, 30-day readmission or 30-day A&E attendance (in DAR and HES). Confidence intervals of proportions were calculated using the Clopper and Pearson method; proportions were compared using $\chi^2$ test with continuity correction. Analysis was performed using the ‘R’ statistical programming language [29] with a significance level of 5%.

**Results**

**DAR and HES matching**

In total, 215 BT procedures (83 patients) were extracted from DAR and 203 BT procedure episodes (85 patients) were extracted from HES. Of these, 152 procedures (59 patients) could be matched. 63 procedures in DAR were not matched in HES. The known reasons for being unable to match these included: 43 were from centres outside of England; three were known to have used a different method of reimbursement which meant that the procedures were not available from HES. The remaining 17 procedures were likely to have been miscoded in HES and therefore not identified by our search rules. From HES, 51 procedure episodes had no matching DAR record. The known reasons for not being able to match these included: three procedures were conducted in one patient who did not consent to data entry into DAR. Of the remaining 48 unmatched cases, some may have been miscoded in HES and therefore not BT procedures while others may not have had data entered in DAR at the time of data extraction. The sole manufacturer of the BT device confirmed that there were no UK centres carrying out BT procedures who were not contributing data to DAR.

Considering cases in England only (DAR 172, HES 203), the total number of procedures (including those captured in neither database) was estimated to be 230, using capture-recapture analysis [28] with maximum likelihood estimation. Based on this, the estimated coverage of DAR is $172/230 = 74.8\%$ and the estimated coverage of HES is $203/230 = 88.3\%$. Approximately two thirds ($152/230 = 66.1\%$) had records in both sources.

**Patient characteristics**

Table 1 shows the baseline characteristics of patients in DAR, HES and the matched cohort. This shows the two cohorts to have comparable demographic and disease characteristics. Table 2 shows the baseline characteristics of patients in DAR (total and matched cohort), compared with those enrolled in three clinical trials (AIR (Asthma Intervention Research) [1], AIR2 [2] and RISA (Research in Severe Asthma) [3]); patients selected to receive BT in routine clinical practice were, on average, older, had lower baseline FEV$_1$ (except for RISA trial) and lower AQLQ scores. Baseline FEV$_1$ and AQLQ data were available for 51/59 and 34/59 patients in the matched cohort respectively.

**Safety outcomes**

Table 3 reports the safety outcomes from all DAR procedures, all HES procedure episodes and the matched cohort. There were no significant differences in any of the measures of safety (procedural complications, post-procedure overnight stay, readmissions and A&E attendances within 30 days) between BT1, BT2 and BT3 (the

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| Table 1. Baseline characteristics of BT patients. |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|                | All patients    | Matched patients |
|                | DAR             | HES             | DAR             | HES             |
| Mean age at BT1 (years) | 43.5 ± 12.0 (n = 83) | 44.4 ± 12.4 (n = 85) | 42.6 ± 12.1 (n = 59) | 42.7 ± 12.0 (n = 59) |
| Range          | 21–69           | 21–74           | 21–69           | 21–69           |
| Female (%)     | 71               | 74.1             | 78.0            | 78.0            |
| Pre-bronch FEV$_1$ (% predicted) | 70.2 ± 21.8 (n = 65) | 70.7 ± 21.6 (n = 51) | 72.7 ± 15.7 (BT, n = 190) | 72.7 ± 10.4 (BT, n = 55) |
|               | Range 18–109    | Range 15.8–6.31 | 79.7 ± 15.1 (C, n = 98) | 76.1 ± 9.3 (C, n = 54) |
| AQLQ score    | 3.74 ± 1.13 (n = 48) | 3.67 ± 1.11 (n = 34) | 4.30 ± 1.17 (BT, n = 80) | 5.6 ± 1.1 (BT, n = 4) |
|               | Range 1.0–6.31  | Range 1.58–6.31 | 4.32 ± 1.21 (C, n = 96) | 5.7 ± 0.9 (C, n = 4) |
|               |                 |                 | 4.72 ± 1.06 (C, n = 96) |                 |

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* n is the number of patients for whom data were available.
Table 3. Safety outcomes.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>All procedures</th>
<th>Matched procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DAR</td>
<td>HES</td>
</tr>
<tr>
<td>Procedures with any reported</td>
<td>41/215 (19.1;4.0-25.0)</td>
<td>-</td>
</tr>
<tr>
<td>respiratory event (%;95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures with complications</td>
<td>16/215 (7.4;4.3-11.8)</td>
<td>13/203 (6.4;3.5-10.7)</td>
</tr>
<tr>
<td>(%;95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures followed by readmission within 30 days:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) for any cause (%;95% CI)</td>
<td>11/207 (5.3;2.7-9.3)</td>
<td>28/203 (13.8;9.4-19.3)</td>
</tr>
<tr>
<td>b) for respiratory cause AND</td>
<td>11/207 (5.3;2.7-9.3)</td>
<td>14/203 (6.9;3.8-11.3)</td>
</tr>
<tr>
<td>emergency admission (%;95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures followed by A&amp;E attendance within 30 days:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a) for any cause (%;95% CI)</td>
<td>1/207 (0.5;0.0-2.7)</td>
<td>19/203 (9.4;5.7-14.2)</td>
</tr>
<tr>
<td>b) for respiratory cause AND</td>
<td>1/207 (0.5;0.0-2.7)</td>
<td>2/203 (1.0;0.1-3.5)</td>
</tr>
<tr>
<td>not admitted (%;95% CI)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Procedures followed by overnight stay (%;95% CI)</td>
<td>47/215 (21.9;16.5-28.0)</td>
<td>92/194 (47.4;40.2-54.7)</td>
</tr>
</tbody>
</table>

* Matched procedures with an event reported in either DAR or HES alone, or both.

In DAR, 41/215 BT procedures (19.1%) mentioned a respiratory event, however only 16/215 (7.4%) reported unanticipated events. In total, 73 events (in 27/83 patients) were reported and of these, 36 were related specifically to asthma: wheeze (15), exacerbation/acute asthma attack (12), drop in FEV1 (5), bronchospasm (3) and deterioration of asthma (1). Some form of breathlessness/infection worsening was seen in 28: chest pain/twinges/tightness (12), shortness of breath/dyspnoea (4), cough/production of sputum (6), chest infection/pneumonia (4) and raised temperature/pyrexia (2). Rare reports included: inflamed airways/bleeding (2), significant desaturation (1), slight atelectasis (1), LLL (left lower lobe) collapse (1), left rib fracture (1), metabolic acidosis/lactic acidosis (1) and procedure being stopped/early termination (2). There were only two recorded device problems, both related to catheters; one was changed after two activations when a spark was noticed, in another kinking and infolding was reported after treatment of the right upper lobe.

For the four binary safety outcomes, only the data from the matched cohort (152 procedures) were used to calculate the event rates. One reason for this is that they are all confirmed BT cases, whereas some cases in HES may be miscoded and not BT procedures. In addition, there are cases from the matched cohort which report events in DAR that are not recorded in HES and vice versa, so counting procedures which have an event reported in either DAR, HES or both may be considered to give a reliable estimate of the true rates. Contingency Tables 4–6 illustrate the occurrences of safety events in the matched cohort.

In the matched cohort, procedural complications were reported in 17/152 procedures (11.2%; 13/59 patients), but these did not correspond between DAR and HES in all cases.

In general there were more reports of 30-day readmissions in HES than in DAR (for any cause and any admission method), however the 30-day readmissions considered relevant to BT safety outcomes were emergency readmissions for respiratory cause, rather than all-cause/planned readmissions. Of the emergency readmissions recorded in HES, four were excluded on the basis of being non-respiratory cause after review by the BT steering group (ICD-10 main codes R10.3, N39.0, A41.9 and T82.7). In the matched cohort, 18/152 procedures (11.8%; 15/59 patients) were followed by an emergency readmission within 30 days for respiratory cause. ICD-10

Table 4. Matched cohort: numbers of procedures with procedural complications in DAR or HES alone, or both.

<table>
<thead>
<tr>
<th></th>
<th>DAR—Y</th>
<th>DAR—N</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HES—Y</td>
<td>3</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>HES—N</td>
<td>10</td>
<td>135</td>
<td>145</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>139</td>
<td>152</td>
</tr>
</tbody>
</table>

Table 5. Matched cohort: numbers of procedures followed by emergency respiratory readmission within 30 days in DAR or HES alone, or both.

<table>
<thead>
<tr>
<th></th>
<th>DAR—Y</th>
<th>DAR—N</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HES—Y</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>HES—N</td>
<td>5</td>
<td>134</td>
<td>139</td>
</tr>
<tr>
<td>Total</td>
<td>10</td>
<td>142</td>
<td>152</td>
</tr>
</tbody>
</table>

* 1 DAR case had missing data.

Table 6. Matched cohort: numbers of procedures followed by respiratory A&E attendance within 30 days (without hospital admission) in DAR or HES alone, or both.

<table>
<thead>
<tr>
<th></th>
<th>DAR—Y</th>
<th>DAR—N</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>HES—Y</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>HES—N</td>
<td>0</td>
<td>151</td>
<td>151</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>151</td>
<td>152</td>
</tr>
</tbody>
</table>

The online supplement contains all data for BT1, BT2 and BT3 reported separately, together with analyses of the differences.)
codes can also identify whether a readmission was due to a complication of a previous procedure and only four of the cases in HES were coded as such.

In the matched cohort, 13/152 procedures (8.6%; 13/59 patients) were followed within 30 days by an A&E admission for any cause. A&E attendances were rarely reported in DAR however, and the reason for attendance was not always reported in HES, leaving only 1/152 procedures (0.7%) followed within 30 days by an A&E attendance positively recorded as respiratory cause, and not resulting in a hospital admission.

Overall, 31/152 procedures (20.4%) in the matched cohort were associated with at least one safety issue (procedural complication, emergency respiratory readmission or respiratory A&E attendance (without subsequent hospital admission) within 30 days).

In the matched cohort, 70/152 procedures (46.1%) were followed by an overnight stay. However, the proportions of procedures followed by an overnight stay were reported as significantly higher in HES (47.4%) than in DAR (21.9%), \( p < 0.01 \). There was no significant difference in the rates of overnight stay between BT1, BT2 and BT3.

Discussion

This is the first presentation of ‘real-world’ clinical registry data for BT and there are no similar data anywhere worldwide. The aim of this study is to publish procedural and short-term safety outcomes of BT in routine clinical practice and it focuses on the safety of the procedure as assessed by registry data which have been validated against routine hospital statistics. The strength of our study is that we have achieved almost 100% UK coverage of BT procedures being carried out post licence through the use of the two independent data sources. Additionally, we were able to obtain confirmation from the sole manufacturer of the BT device that there were no UK centres carrying out BT procedures who were not contributing data to DAR. DAR was used to capture early clinical experience of BT in the UK. HES was used to assess coverage of DAR and to obtain independent safety information for procedures carried out in England.

This study found that 20.4% of procedures in the matched cohort were affected by at least one safety issue [procedural complication, emergency respiratory readmission or respiratory A&E attendance (without subsequent hospital admission) within 30 days). The safety data reported here are not directly comparable with the measures reported in previous trials, however the reported hospitalisation rates for the previous trials may be an indication of safety: AIR2 [1] 8.4% (16/190), AIR [2] 7.3% (4/55) and RISA [3], 26.7% (4/15). The explanation for the apparently higher rate of safety events in clinical practice compared with AIR2 and AIR trials could be related to the age and severity of the disease of those treated, as the patients included in these two clinical trials had moderate to severe asthma only. The observed rate in clinical practice is closer to the RISA study which included more severe asthma patients.

A benefit of using the matched cohort is that they are all confirmed BT cases, and the information contained in DAR and HES is combined to give a more reliable estimate of safety event rates. However a limitation is that the rates may be under- or over-estimates due to the reduction in the denominator. For example the use of HES excludes any group outside England, which in this study meant that 43 procedures were excluded from the matched cohort.

A further benefit of using the matched cohort is to help assess the extent of potential reporting bias. In DAR, only events entered into the ‘Unanticipated Procedural Morbidity’ field were reported as complications as these may be considered potential safety issues. Centres were encouraged to enter ‘unanticipated’ procedural morbidity, so mild/expected events may be under-reported. On the other hand, the reporting of such events (as free text) is subjective, with some centres reporting more minor events than others, and which may not be coded as complications in HES. This could explain the higher number of complications reported in DAR for the matched cohort. In HES, variation in interpretation of clinical notes by clinical coders could potentially lead to differences in recording complications. For these reasons, any mention of events in DAR which could be regarded as being related to safety were studied, with those related specifically to asthma being reported.

Overall, many of the reported adverse events could be perceived as ‘anticipated’ and only four cases of chest infection/pneumonia and one case each of LLL collapse, rib fracture and metabolic acidosis were considered by the BT steering group as significant ‘unanticipated events’.

A further strength of this study is that the two data sources are independent and complementary. In general, DAR contains richer clinical information about complications, reasons for overnight stay and hospital admissions, though there is variation in how different centres complete data fields. HES reported higher rates of readmission and A&E attendance, possibly suggesting more timely and complete information. However, careful scrutiny of HES fields for admission method and diagnoses was required to ensure that planned readmissions, readmissions for non-respiratory causes and A&E attendances for non-respiratory causes were not included in the reported rate of safety events following the BT procedure. Also, to avoid double counting of events in HES, only A&E attendances which did not subsequently result in a hospital admission were included in the overall rate of safety events. A possible reason for the lower rates in DAR is that recording
of healthcare usage may rely on patient recall of GP (general practitioner) and hospital visits; additionally, patient notes may be incomplete if an A&E attendance or readmission was to a different Trust than that which conducted the BT procedure. Significant delays in recording healthcare usage in DAR can also occur because this information is only entered when the next procedure or 6 month follow-up has occurred.

There was an unexplained difference in the rate of post-procedure stay reported by the two sources. Some patients have planned pre-procedure admissions which may potentially result in incorrect recording of procedure dates in HES, and the 46.1% reported post-procedure stay (combined data from the matched cohort) does appear high compared with hospitalisation rates in previous trials. The 21.9% rate for all procedures in DAR is closer to the RISA trial and additionally, in DAR, some stays are reported as precautionary which may be due to the severity of asthma in patients being treated in clinical practice.

Compared with three clinical trials, this study reported that patients selected to receive BT in routine clinical practice were on average older, had lower baseline FEV1 (except for RISA trial) and lower AQLQ scores. However, baseline FEV1 and AQLQ data were not available for all patients in the matched cohort, a consequence of registry-based data collection rather than a clinical trial setting.

Conclusions

This paper presents, for the first time, an assessment of procedural and short-term safety of BT in routine UK clinical practice, using combined information from a clinical registry with good coverage and routine administrative data. The data suggest that a higher proportion of patients are experiencing adverse events than reported by two of the published clinical trials, however only a minority of these were considered significant by the treating clinician. In addition, clinical practice has been to treat patients with severity levels of asthma comparable with the RISA trial population (high severity), rather than the less severely affected patients in the pivotal AIR2 or AIR studies (moderate to severe). The collection of registry data has helped to place the findings of previous experimental studies of BT in the context of routine clinical practice and the ongoing data collection will enable a study of longer term safety and clinical effectiveness when data from a longer period of follow-up are available.

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Declaration of interest

LGH has received grant funding from Medimmune, Novartis UK, Roche/Genentech Inc, AstraZeneca and GlaxoSmithKline, have taken part in advisory boards and given lectures at meetings supported by GlaxoSmithKline, RespiVert, Merck Sharp & Dohme, Nycomed, Boehringer Ingelheim, Novartis and AstraZeneca. LGH has received support funding to attend international respiratory meetings (AstraZeneca, Chiesi, Novartis, Boehringer Ingelheim and GlaxoSmithKline) and has taken part in asthma clinical trials (GlaxoSmithKline, Schering-Plough, Synairgen and Roche/Genentech) for which his institution was remunerated. LGH is Academic Lead for the Medical Research Council Stratified Medicine UK Consortium in Severe Asthma which involves industrial partnerships with Amgen, Johnson & Johnson, Genentech/Roche, AstraZeneca/Medimmune, Aerocrine and Vitalograph. RN was PI (principal investigator) on several of the thermoplasty trials, and has received honoraria for lecturing and attending advisory boards from Boston Scientific.

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