Variation in Utilization and Need for Tympanostomy Tubes across England and New England

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Objectives To compare rates of typmanostomy tube insertions for otitis media with effusion with estimates of need in 2 countries.

Study design This cross-sectional analysis used all-payer claims to calculate rates of tympanostomy tube insertions for insured children ages 2-8 years (2007-2010) across pediatric surgical areas (PSA) for Northern New England (NNE; Maine, Vermont, and New Hampshire) and the English National Health Service Primary Care Trusts (PCT). Rates were compared with expected rates estimated using a Monte Carlo simulation model that integrates clinical guidelines and published probabilities of the incidence and course of otitis media with effusion.

Results Observed rates of tympanostomy tube placement varied >30-fold across English PCT (N = 150) and >3-fold across NNE PSA (N = 30). At a 25 dB hearing threshold, the overall difference in observed to expected tympanostomy tubes provided was –3.41 per 1000 child-years in England and –0.01 per 1000 child-years in NNE. Observed incidence of insertion was less than expected in 143 of 151 PCT, and was higher than expected in one-half of the PSA. Using a 20 dB hearing threshold, there were fewer tube insertions than expected in all but 2 England and 7 NNE areas. There was an inverse relationship between estimated need and observed tube insertion rates.

Conclusions Regional variations in observed tympanostomy tube insertion rates are unlikely to be due to differences in need and suggest overall underuse in England and both overuse and underuse in NNE. *(J Pediatr 2016;■■:■■-■■).*

Otitis media is the most common childhood diagnosis with 2.2 million children affected before school age, and with the highest prevalence occurring between the ages of 6 months and 3 years.[1] In 90% of children, a middle ear effusion develops subsequently and in 40% it persists for more than 3 months.[1,2] Insertion of tympanostomy tubes (grommets) to relieve otitis media with effusion (OME) or reduce recurrent otitis media is the most common pediatric procedure in the US, accounting for more than 20% of all pediatric ambulatory surgery, with annual associated costs exceeding $5 billion.[3]

Rates of tympanostomy tube insertion are known to vary across regions in the US, England, Canada, Finland, and Norway.[4-10] Although Black found that there was a reduction in the mean rate for England following clinical guidelines issued in the 1990s, which were already one-half the rate of the US, substantial variation in rates of treatment continued.[2,6,11-14] This variation could be due to differences in need and preferences of patients, and, for this procedure, the preferences of their parents. However, using RAND–University of California at Los Angeles appropriateness criteria[7,8] and patient data from chart reviews, a significant majority of US tympanostomy insertions were found to be inappropriate. For example, a key finding from a study of tympanostomy insertions in England[15] was the suggestion that there appeared to be both over- and undertreatment (ie, operations were carried out for patients who were unlikely to benefit and not performed in patients for whom benefit was likely).

In this study, we moved from descriptions of variations in rates of treatment to normative assessments, by developing estimates of "need" in terms of likely capacity to benefit in England and Northern New England (NNE). We used a model based on England's National Institute of Health and Care Excellence (NICE) guidelines,[16] which are similar to those developed by the American Academy of Pediatrics (AAP).[1] We postulated overuse and underuse of tympanostomy tubes in 2 countries with very different funding and organization of health care.

AAP	American Academy of Pediatrics
NHS	National Health Service
NICE	National Institute for Health and Clinical Excellence
NNE	Northern New England
O:E	Observed to expected ratio
OME	Otitis media with effusion
PCT	Primary Care Trusts
PSA	Pediatric surgical areas

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Methods

We measured the use of tympanostomy tubes in children ages 2-8 years residing in Maine, Vermont, and New Hampshire, and registered with the English National Health Service (NHS) during the period 2007-2010. For NNE we used pediatric all-payer administrative datasets limited to children with 1 or more months' enrollment in a Medicaid or commercial insurance plan that met state-level data-reporting mandates.[17] For England, private paying patients were not included. This study was approved by the Committee for the Protection of Human Subjects at Dartmouth College. In England, the use of secondary data in an anonymized and aggregated form does not require ethical approval.

We included both inpatient and outpatient cases and included tube insertions listed as both primary and secondary procedures. For NNE, tympanostomy tube placements were identified by claims with Current Procedural Terminology codes 69433 and 69436 in addition to *International Classification of Diseases, Ninth Revision* diagnosis codes of OME of chronic middle ear disease (381.1, 381.19, 381.20, 381.29, 381.3, and 381.4). It should be noted that claims do not distinguish bilateral from unilateral disease. For England, observed rates were calculated by using a 4-year average (2007/2008-2010/2011). Tympanostomy tube insertion was identified using NHS procedure codes with *International Classification of Diseases, Ninth Revision,10th Revision* diagnosis codes (H652, H653, H654, and H659) and indicates that a child had 1 or 2 tubes placed.

For NNE, rates are reported across Dartmouth Atlas Pediatric Surgical Areas (PSA; N = 30) that were developed for The Dartmouth Atlas of Children's Health Care in NNE.[4] These regions represent markets of pediatric surgical care. Overall, 67.6% of children residing within the areas received tubes from providers within the area. In England, rates are reported for residents of Primary Care Trusts (PCT; N = 151) that were defined geographically by the NHS. Privately financed procedures are not reported. Observed rates were calculated as the number of procedures divided by the study population within each region.

Calculating Expected Number of Tube Insertions

An epidemiologic model was developed to estimate "expected" tympanostomy tube placement.[15] OME usually is transitory and the expected benefit from ear tubes depends on the time lapsed from onset of diagnosis to when treatment is considered.[2,18-23] Our epidemiologic model unites 2 probabilities: age-specific incidence and the course of OME disease. The model starts with the population at risk of developing OME and includes the probability that a relative portion of those at risk will develop bilateral OME with hearing loss of +25 and +20 dB. The recovery rate determines the proportion of children with resolved OME and hearing loss, and so "returning" to the susceptible population. Patients for whom a diagnosis of OME is confirmed after 3 months of "watchful waiting" have a capacity to benefit (ie, improvement of hearing) from tympanostomy tubes and should be considered for surgical intervention according to NICE guidance and AAP guidelines.[1,16] The probabilities are used in a Monte Carlo simulation (ie, through repeated sampling) to model the expected number of children with capacity to benefit from tympanostomy tubes for OME. We calculated expected incidence of bilateral OME with a hearing loss of both +25 and +20 dB with 10 000 iterations of the model to calculate 90% CI in the mean estimates.

We assume that 46% of children with bilateral OME will have a hearing threshold of +25 dB and 35% a hearing threshold of +20 dB.[15,24] The US AAP guidelines recommend consideration of tympanostomy surgery with a +20 dB or greater threshold, and the English guidelines recommend surgery for a +25 dB or greater threshold.[1,16] Both guidelines also suggest tube insertion for children with additional risk factors.

Model Validation

The above model parameters and incidence calculations were iteratively discussed and refined in consultation with a Project Steering Group at the London School of Economics and Political Science.[15] Participants included experts in audiology, otolaryngology, general practice, and epidemiology, and were invited to validate the model's components and overall accuracy. The group judged the model to be a judicious representation of the NICE care pathway and treatment process governing OME. The parameters[15] used in this study were unchanged.

Analyzing Utilization Differences

We calculated the difference between observed and expected incidence by geographic area by age. Expected and observed rates were aggregated across age groups, and the total difference was calculated by geographic area. Given that the observed number of pressure equalization tubes is based on actual tube placement, the observed counts are the same for each region in the observed to expected ratio (O:E), and the expected counts differ for 20 and 25 dB hearing loss. We calculated 95% CI for these ratios assuming a binomial distribution for observed counts and the expected counts as known constants. We used simple linear regression to test the association between rates of observed and expected tube insertions.

Results

From the administrative data we identified 6052 tympanostomy tubes provided for children in NNE, and 66 414 tubes for children in England over the study period. (**Table I**) The mean age of children receiving tympanostomy tubes in NNE and England was 3.9 years and 4.9 years, respectively, and the majority was male (58.5% for NNE; 55.5% for England). The observed rate of tympanostomy tubes provided in England was 4.01 per 1000 child-years and 83% higher in NNE at 7.34 per 1000 child-years.

Regional rates of surgery differed widely in both countries. In NNE, observed incidence varied more than 3-fold across PSA (3.79 to 13.15 per 1000); in England, observed provision of tympanostomy tubes 0 more than 30-fold across PCT (0.45 to 14.45 per 1000). Using the +25 dB threshold, expected incidence for NNE (7.28 to 7.46 per 1000) and England

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Table I. Observed and expected tympanostomy tube insertions, by guideline hearing threshold

	Observed‡	Expected§	Observed-expected difference	Observed-expected per 1000	O:E
25 dB*					
Total NNE	6052	6,059	−7	−0.01	1.00
By payer:					
Medicaid	2960	3,121	−161	−0.19	0.95
Commercial	3092	2938	+154	+0.19	1.05
Total England	66 414	123 797	−57 383	−3.41	0.54
20 dB†					
Total NNE	6052	7963	−1911	−3.27	0.76
By payer:					
Medicaid	2960	4102	−1142	−1.39	0.72
Commercial	3092	3861	−769	−0.93	0.80
Total England	66 414	162 705	−96 291	−5.82	0.41

*Hearing threshold guideline recommended by NICE guidance in England.
†Hearing threshold guideline recommended by AAP guidance in the US.
‡Four-year observed number of tympanostomy tubes provided in the study period. These counts are the same for both 20 dB and 25 dB observed to expected ratios.
§Four-year expected number of tympanostomy tubes provided, estimated by an epidemiologic model. (See Appendix).

(7.33 to 7.70 per 1000) varied little. The +20 dB threshold yielded similarly low expected variation for both study areas (NNE: 9.57 to 9.81 per 1000; England: 9.63 to 10.25 per 1000) (not shown).

Tables I–III (**Tables II–III**; available at www.jpeds.com) presents net differences in expected to observed rates at both hearing thresholds for NNE and England. In NNE, the overall observed total number of insertions was close to the expected number for a +25 dB threshold (observed to expected difference −7; observed minus expected rate −0.01 per thousand; O:E 1.00). Using the +20 dB threshold, there were far fewer observed tube insertions than expected (observed to expected difference −1911; observed minus expected rate −3.27 per thousand; O:E 0.76). In England, the observed total number of insertions was much lower than expected for both hearing thresholds. Using the +25 dB guideline threshold, the observed to expected difference was −57 383; observed minus expected rate −3.41 per thousand; O:E 0.54. Using the +20 dB guideline threshold, the observed to expected difference was −96,291; observed minus expected rate −5.82 per thousand; O:E 0.41.

Figure 1 depicts the small area differences in observed to expected incidence centered at a ratio of 1 (ie, no difference) across NNE and England with 95% CI. With a +25 dB threshold, the observed incidences were less than expected in all but 8 PCT, and higher than expected rates were observed in about one-half of the PSA. With a +20 dB threshold, there were fewer than expected in all but 2 in England and seven NNE areas.

There was a weak inverse relationship (**Figure 2**) between estimated need of tube insertion and observed rates (England $P < .01$, $R^2 = 0.05$; NNE $P < .05$, $R^2 = 0.20$); particularly for NNE, areas with relatively higher needs generally had lower observed rates.

Sensitivity Analyses

Although NNE is socioeconomically diverse, there are only small differences between rates of tympanostomy procedures between those insured by Medicaid (7.53 per 1000 person-years) and commercial (7.16 per 1000 per-years) insurance plans (**Table IV**). There is no equivalent proxy for stratifying by socioeconomic risk at the individual level for England.

Discussion

This study confirms previous observations that tympanostomy tube insertion for OME varies markedly and demonstrates that although England had a lower mean rate than NNE, its variation in rates in England was much greater.[7,8,15] The magnitude of observed variations in procedure rates in both countries is unlikely to be explained by the regional differences in the incidence of OME and raises the question: "Which rate is right?" Using persistent OME and objective hearing loss as the best evidence-based assessment of likely benefit, this study provides indication of possible underuse in some areas of England and NNE, and possible overuse in other areas of NNE. However, these measures may overestimate the need for tympanostomy tubes insertion for 3 reasons.

First, the evidence for long-term benefit of tympanostomy tubes is weak. Historically, tympanostomy tube insertion was considered appropriate to prevent recurrent episodes of acute

Table IV. Study population and characteristics for children ages 2-8 years old who received tympanostomy tubes for treatment of otitis media with effusion

Characteristics	England	NNE
Study population (in child-y)*	16 511 180	824 035
Number of children receiving tube insertions during study period.	66 414	6052
Children receiving tube insertion:		
Age (mean in y)	4.9	3.9
Sex (% male)	55.5	58.5
Observed insertion rate (per 1000 child-y)		
All	4.01	7.34
Medicaid		7.53
Commercial		7.16

*The total child-years includes children over a 4-year study period. English data are for children registered with the NHS, and NNE data are limited to children enrolled in Medicaid and reporting commercial insurance plans. This includes 80% in Maine (2010 Medicaid data were not available), 70% in New Hampshire, and 92% in Vermont.

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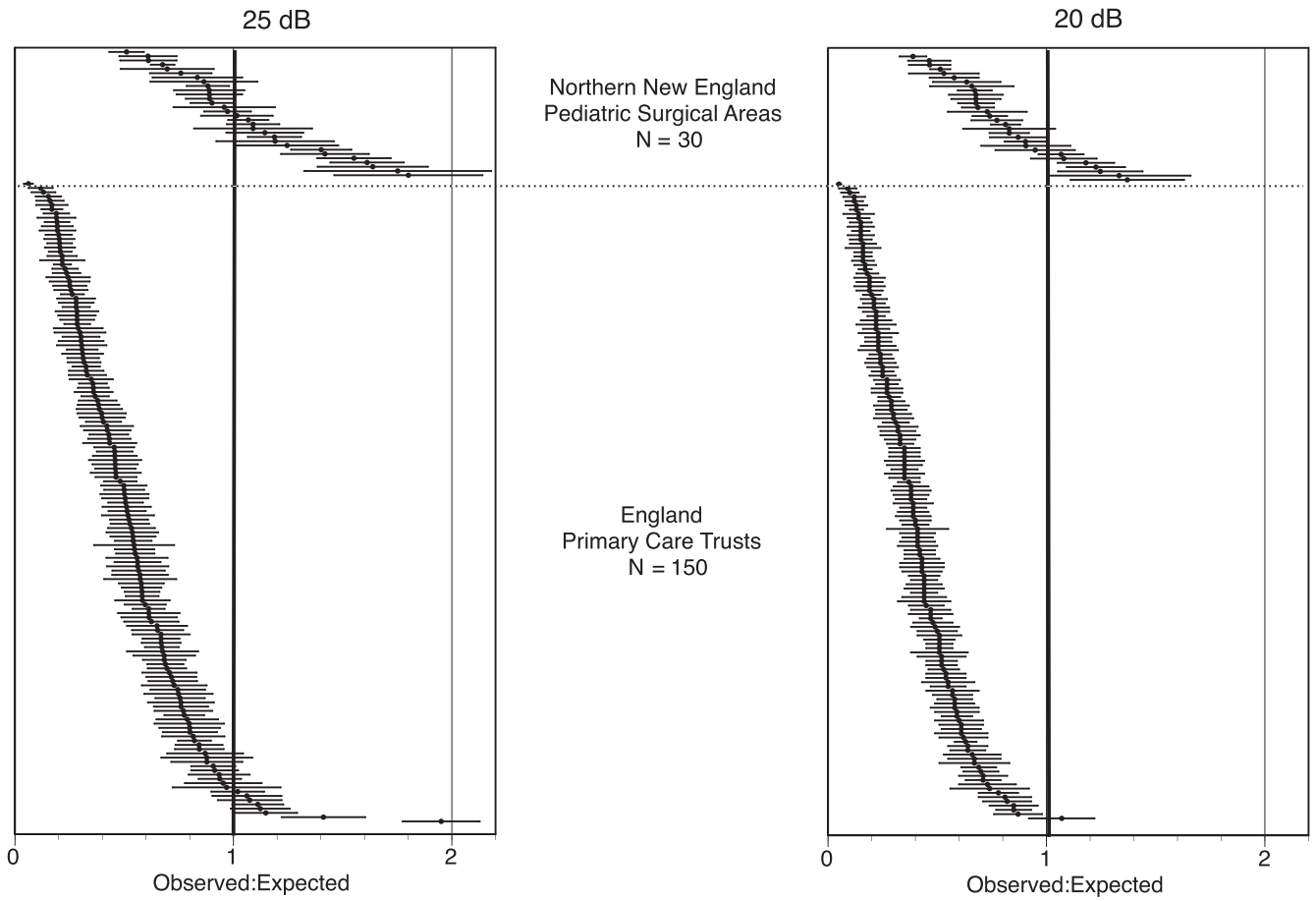

Note: Each dot represents one Pediatric Surgical Area (northern New England) or Primary Care Trust (England). A ratio of 1 indicates that the number of tube insertions equaled the number expected from the model calculating need. Greater than 1 indicated more tube insertions occurred than predicted by the model.

Figure 1. Ratio of observed to expected number of tympanostomy tubes by regions for 25 dB and 20 dB hearing thresholds with 95% CI.

otitis media or for hearing loss from OME.[18,19] Although OME spontaneously resolves for most children, a proportion of them suffer from persistent effusion that may cause impaired hearing which, in some children, can affect educational performance, language development, and/or behavior.[1,25] Tympanostomy tubes for OME have been shown to reduce OME and improve hearing, but longer-term benefits have been harder to detect,[13,20-22] particularly with regard to improved language and cognitive development.[13,19] Therefore, even guidelines-based assessments of overuse and underuse may overestimate the benefit from tympanostomy tubes.[7,8,11,20,22]

Second, with the exception of the use of tubes for reducing OME and improvement of hearing loss,[23] the 3 major guidelines are based largely on observational studies and professional opinion.[1,16,19] For example, a recent guideline recommends that "clinicians may perform tympanostomy tube insertion in at-risk children with unilateral or bilateral OME that is unlikely to resolve quickly as reflected by a type B (flat) tympanogram or persistence of effusion for 3 months or longer."[19] Risks are defined as "sensory, physical, cognitive, or behavioral factors that place children who have OME at increased risk for developmental difficulties (delay or disorder)." Even though the face validity of these recommendations seems high, the evidence supporting benefit remains limited. Broad definitions of the children likely to benefit adds to the potential for inadvertent overuse and underuse. In the same guidelines, it is recommended that

> Clinicians may perform tympanostomy tube insertion in children with unilateral or bilateral OME for 3 months or longer (chronic OME) AND symptoms that are likely attributable to OME that include, but are not limited to, balance (vestibular) problems, poor school performance, behavioral problems, ear discomfort, or reduced quality of life.

The 2 other current guidelines also suggest consideration of tube placement for at-risk children.[1,16] In England, the majority of insertions were recommended on the basis of "exceptional circumstances."[20]

Third and finally, audits suggest that many tube insertions may not be appropriate. A multicenter cohort study in New

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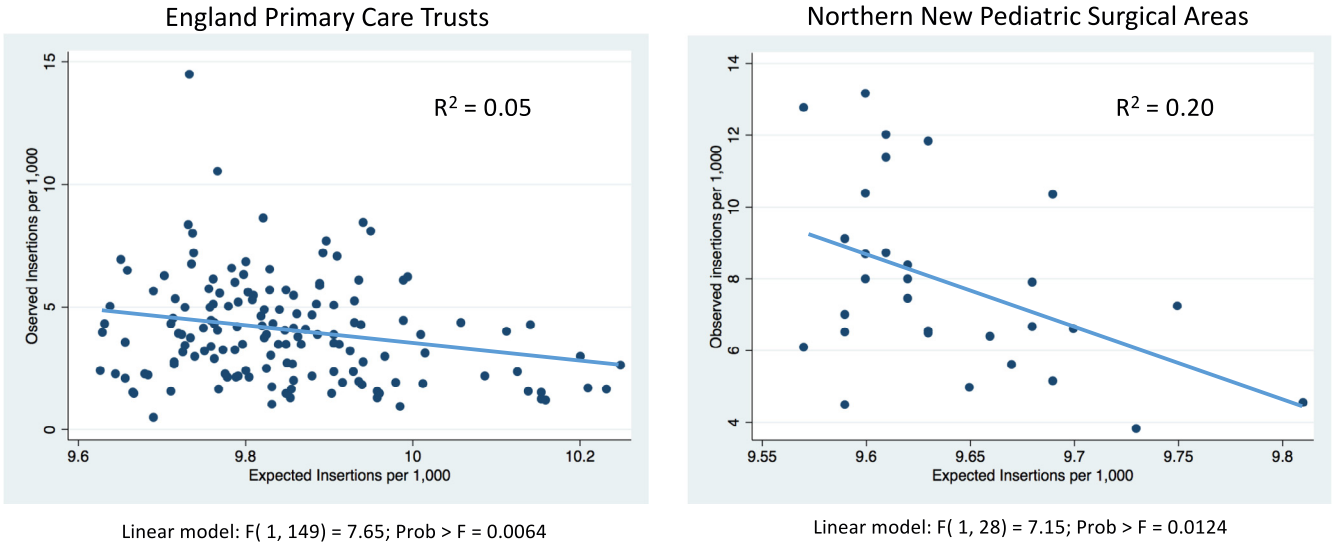

Figure 2. Observed and expected tympanostomy tube insertions per 1000 child-years across regions of England and NNE.

York found that only 7.5% of tympanostomy tubes provided were concordant with clinical practice guidelines.[7] In England, a recent multicenter study found that only 32% of ear tubes were in concordance with the NICE criteria.[20] In England, epidemiologic modeling indicates that about 31 000 children would have benefited from the procedure (25 dB threshold), but only about 16 600 operations were undertaken. If the previous clinical audit study is accurate,[20] two-thirds of those 16 600 were not consistent with guidelines. In NNE, using the US 20 dB threshold, about 8000 children would have benefited from the procedure, but applying the findings of the New York State appropriateness study,[7] less than 1000 of the operations would have been consistent with guidelines.

Taken together, the lack of evidence for long-term benefit, the unavailability of clinical trials for the most common indications, and the low level of appropriateness of tube insertions are deeply troubling and raise questions about current utilization patterns. The overall lower rates of pressure equalization tube utilization in England likely reflects the greater degree of scrutiny of nonemergent procedures in a national health system with a fixed budget, and England's more "conservative" clinical practice guidelines. The widespread differences between utilization and estimated need (ie, expected procedures) indicate that population differences are unlikely to explain variation in use. The magnitude of the variation across both countries' regions indicate that differences in country-specific insurance systems, reimbursement policies or the organization of care are unlikely to be dominant factors in explaining the variation. Generally, research into the causes of regional variation into other procedures have found the primary determinant to be differences in physician practice styles reflecting professional uncertainty about the utility of the procedure in a given patient. This is compounded by the difficulty of physicians to diagnose patient and family decision preferences when medical care, watchful waiting, or procedures all have some degree of benefit and risk.[26-28]

There are several limitations to the study. The first is the uncertainty of the model parameters. Even though tympanostomy tube insertion is a common pediatric procedure, many gaps remain in our knowledge of the natural history of OME and the benefit of treatment.[29] Population-based prevalence data of OME with hearing loss is not available for small areas, and are impractical to collect. To estimate these rates, we applied historical rates available in the literature to age-specific population counts. Since the advent of conjugate pneumococcal vaccines, the incidence of pneumococcal respiratory tract infections includes acute otitis media, recurrent acute otitis media, and persistent OME has decreased substantially in many countries.[30-32] The model does not include more detailed patient and caregiver characteristics or care preferences. The parameters of the model are, therefore, estimates of average expected procedures based upon the framework of current objectively based clinical guidelines. Additional subjective criteria cannot be modeled, such as children with special needs[1] or those with behavioral problems without evidence of hearing loss.[19] Nevertheless, the quality of evidence (ie, randomized clinical trials) for tympanostomy tube efficacy is strongest in those with hearing loss demonstrated with audiometry,[23] the criteria that we used in this study.

The observed number of tympanostomy tubes is limited to patients insured by Medicaid and commercial plans in NNE. The 3 states have somewhat different reporting requirements for commercial insurance and some children remain uninsured. Our data capture 92% of the pediatric population of Vermont, 80% of Maine, and about 70% of New Hampshire.[4] Maine Medicaid data from 2010 were not available at the time of this study. Observed number of tympanostomy tubes includes only patients treated in the NHS, and not those procedures paid for privately. Although the precise number is not known, the percentage of tonsillectomies, a procedure also performed by otolaryngologists in both countries, performed in United Kingdom private practice is estimated to be about 16%

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and total private sector expenditure on healthcare in the United Kingdom (2011) is 17.2%.[33] The lack of private practice data was unlikely to substantially affect the results of the study.

Although the epidemiologic risk for OME is multifactorial, and includes such factors as race, socioeconomic status, exposure to cigarette smoke, and daycare attendance,[21,25,34] our model does not include information on these patient and environmental characteristics. In NNE, the overall rates of tube placement by insurance type, a socioeconomic indicator, differs by only 5%, but this may not be an accurate indicator of the differing incidence of OME. The NNE children are less racially and ethnically diverse than the children of England, but the differences between NNE and England are small compared with NNE and other regions of the US.[35] Median household income is comparable between nations.[33,35] Economic diversity in NNE is below the national mean as measured by income inequality.[35] The rate of the uninsured population is far below the US average,[35] but not as low as in England, where the entire resident population has access to care provided by the NHS. Although waiting times for surgery in the NHS are a concern for the period of our study, there was a median waiting time of 7.3 weeks (51 days) for tympanostomy tube insertion from the decision to perform the procedure.[36]

This study is novel in its comparison in the use of tympanostomy tubes in regions of the US and in England in relation to the number expected from clinical practice guidelines based on persistent OME and objective measures of hearing loss. The observed rates differ markedly across small areas. Given the magnitude of discrepancy from expected rates, the variation is unlikely to be explained by variation in disease prevalence or need. Using our criteria as a standard of practice, these findings suggest likely overuse and underuse in NNE, and underuse in England. As the English and US guidelines differ and the longer-term benefits of tympanostomy tubes for OME have not been demonstrated,[21] rates based on guidelines may not be a useful guide of patient need. In this circumstance of uncertainty in benefits, implementation of shared decision making could be a useful companion to clinical practice guidelines by providing balanced information on treatment choices, and assisting patients and families in clarifying their health values and treatment goals.[37-41] Higher quality evidence on the benefits of tympanostomy tubes also would improve the decision making process. ■

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Table II. Observed and expected tympanostomy tube insertions by regions of NNE for children age 2-8 years

PSA	Child-years, 2007-2010	4-y expected 2007-2010 for +25 dB Number	4-y expected 2007-2010 for +25 dB Rate	4-y expected 2007-2010 for +20 dB Number	4-y expected 2007-2010 for +20 dB Rate	Observed 2007-2010 Number	Observed 2007-2010 Rate	O:E 25 bB	O:E 20 bB	O:E 95% CI +25 dB upper 95% CI	O:E 95% CI +25 dB lower 95% CI	O:E 95% CI +20 dB upper 95% CI	O:E 95% CI +20 dB lower 95% CI
Augusta	20 558	152	7.38	199	9.70	135	6.57	0.890	0.677	1.040	0.740	0.791	0.563
Bangor	39 886	295	7.41	388	9.73	151	3.79	0.511	0.389	0.592	0.430	0.451	0.327
Berlin	4940	36	7.28	47	9.57	63	12.75	1.752	1.333	2.181	1.322	1.660	1.006
Berlin	20 189	148	7.32	194	9.62	169	8.37	1.144	0.870	1.316	0.972	1.001	0.740
Brattleboro	9299	68	7.29	89	9.59	65	6.99	0.958	0.729	1.190	0.726	0.906	0.552
Brunswick	20 703	152	7.32	199	9.62	154	7.44	1.016	0.773	1.176	0.856	0.895	0.652
Burlington	72 838	536	7.36	705	9.68	573	7.87	1.068	0.813	1.156	0.981	0.879	0.747
Concord	41 483	303	7.30	398	9.60	360	8.68	1.188	0.904	1.310	1.066	0.997	0.811
Derry	10 528	77	7.28	101	9.57	64	6.08	0.835	0.635	1.038	0.631	0.790	0.480
Dover	39 456	291	7.37	382	9.69	408	10.34	1.402	1.067	1.538	1.267	1.170	0.964
Ellsworth	18 046	135	7.46	177	9.81	82	4.54	0.609	0.463	0.741	0.478	0.563	0.363
Exeter	19 009	139	7.30	182	9.60	197	10.36	1.419	1.080	1.616	1.222	1.229	0.930
Keene	13 182	96	7.32	127	9.61	158	11.99	1.638	1.247	1.892	1.384	1.440	1.053
Laconia	28 020	205	7.33	270	9.63	331	11.81	1.612	1.227	1.785	1.439	1.358	1.095
Lebanon	39 609	290	7.32	381	9.62	316	7.98	1.090	0.830	1.210	0.971	0.921	0.739
Lewiston	41 410	307	7.42	404	9.75	299	7.22	0.973	0.741	1.083	0.864	0.824	0.657
Littleton	7236	53	7.35	70	9.66	46	6.36	0.865	0.658	1.115	0.616	0.848	0.469
Manchester	52 356	386	7.37	507	9.68	348	6.65	0.902	0.686	0.997	0.808	0.758	0.615
Middlebury	8289	61	7.30	80	9.60	109	13.15	1.801	1.370	2.137	1.465	1.626	1.115
Nashua	39 997	292	7.30	384	9.59	260	6.50	0.891	0.678	0.999	0.783	0.760	0.596
Newport	7537	55	7.31	72	9.60	60	7.96	1.090	0.829	1.364	0.815	1.038	0.620
Portland	105 483	774	7.34	1,017	9.65	523	4.96	0.676	0.514	0.733	0.618	0.558	0.470
Presque isle	20 839	152	7.30	200	9.59	93	4.46	0.611	0.465	0.735	0.487	0.560	0.371
Rockland	18 797	138	7.36	182	9.67	105	5.59	0.759	0.578	0.904	0.614	0.688	0.467
Rutland	28 469	208	7.31	274	9.61	323	11.35	1.552	1.181	1.720	1.383	1.309	1.053
Sanford	17 794	130	7.33	171	9.63	116	6.52	0.889	0.677	1.051	0.728	0.800	0.554
Springfield	8503	62	7.31	82	9.61	74	8.70	1.191	0.906	1.461	0.920	1.111	0.700
St Johnsbury	8177	60	7.37	79	9.69	42	5.14	0.697	0.530	0.907	0.487	0.690	0.370
Waterville	49 745	365	7.33	479	9.63	322	6.47	0.883	0.672	0.979	0.787	0.745	0.599
York	11 661	85	7.29	112	9.59	106	9.09	1.246	0.948	1.483	1.010	1.128	0.769
Total	824 035	6051	7.34	7953	9.7	6052	7.34	1.000	0.761				

All rates per 1000 child-years.

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Table III. Observed and expected tympanostomy tube insertions by regions of England for children age 2-8 years

PCT	Population 2-8 y, 2007-2010	Expected 2007-2010 (annual average) for +25 dB Number	Rate	Expected 2007-2010 (annual average) for +20 dB Number	Rate	Observed 2007-2010 (annual average) Number	Rate	O:E 25 bB O:E ratio	O:E 20 dB O:E ratio	O:E 95% CIs for +25 dB upper 95% CI	lower 95% CI	O:E 95% CIs for +20 dB upper 95% CI	lower 95% CI
Ashton, Leigh, and Wigan	24 590	184	7.5	242	9.8	120	4.88	0.653	0.497	0.769	0.536	0.585	0.408
Barking and Dagenham	19 028	147	7.7	193	10.2	29	1.50	0.194	0.148	0.265	0.123	0.202	0.093
Barnet	30 665	231	7.5	304	9.9	45	1.45	0.193	0.147	0.249	0.136	0.190	0.104
Barnsley	17 658	132	7.5	174	9.8	86	4.87	0.650	0.495	0.788	0.513	0.599	0.391
Bassetlaw	8 218	61	7.4	80	9.7	59	7.18	0.969	0.737	1.215	0.722	0.925	0.550
Bath and North East Somerset	12 457	92	7.4	121	9.7	28	2.25	0.305	0.232	0.418	0.192	0.318	0.146
Bedfordshire	34 556	257	7.4	337	9.8	153	4.43	0.596	0.454	0.691	0.502	0.525	0.382
Berkshire East	34 555	261	7.5	343	9.9	119	3.44	0.457	0.347	0.538	0.375	0.410	0.285
Berkshire West	38 620	290	7.5	381	9.9	157	4.07	0.541	0.412	0.626	0.457	0.476	0.347
Bexley	19 176	143	7.5	188	9.8	40	2.09	0.280	0.213	0.366	0.193	0.279	0.147
Birmingham East and North	41 127	310	7.5	407	9.9	157	3.82	0.506	0.385	0.585	0.427	0.445	0.325
Blackburn with Darwen Teaching	14 657	110	7.5	144	9.8	62	4.20	0.562	0.427	0.702	0.421	0.534	0.321
Blackpool	10 727	80	7.5	105	9.8	46	4.29	0.573	0.436	0.738	0.408	0.562	0.310
Bolton Teaching	23 502	176	7.5	231	9.8	81	3.43	0.457	0.348	0.557	0.357	0.424	0.272
Bournemouth and Poole Teaching	21 001	158	7.5	207	9.9	79	3.76	0.501	0.381	0.612	0.391	0.465	0.297
Bradford and Airedale Teaching	50 745	383	7.6	504	9.9	264	5.20	0.688	0.524	0.771	0.606	0.587	0.461
Brent Teaching	23 538	183	7.8	240	10.2	40	1.68	0.216	0.164	0.283	0.149	0.216	0.113
Brighton and Hove City	17 914	135	7.6	178	9.9	78	4.33	0.573	0.436	0.700	0.445	0.532	0.339
Bristol	31 406	239	7.6	315	10.0	97	3.09	0.405	0.308	0.486	0.325	0.370	0.247
Bromley	26 152	194	7.4	255	9.8	105	4.02	0.540	0.411	0.643	0.437	0.490	0.333
Buckinghamshire	44 918	330	7.3	434	9.7	159	3.54	0.482	0.367	0.557	0.407	0.423	0.310
Bury	15 727	117	7.5	154	9.8	72	4.58	0.613	0.466	0.754	0.472	0.574	0.359
Calderdale	17 159	128	7.5	169	9.8	98	5.68	0.760	0.578	0.910	0.609	0.692	0.464
Cambridgeshire	47 209	351	7.4	461	9.8	204	4.32	0.582	0.443	0.661	0.502	0.503	0.382
Camden	16 415	124	7.6	163	10.0	21	1.28	0.169	0.128	0.241	0.097	0.183	0.074
Central and Eastern Cheshire	35 337	261	7.4	344	9.7	137	3.86	0.522	0.397	0.609	0.435	0.464	0.331
Central Lancashire	35 959	269	7.5	353	9.8	138	3.84	0.513	0.391	0.599	0.428	0.456	0.326
City and Hackney Teaching	22 414	173	7.7	228	10.2	27	1.18	0.153	0.116	0.211	0.095	0.161	0.072
Cornwall and Isles of Scilly	37 292	274	7.3	359	9.6	187	5.01	0.684	0.520	0.781	0.586	0.595	0.446
County Durham	36 930	275	7.5	362	9.8	232	6.28	0.843	0.641	0.951	0.735	0.723	0.559
Coventry Teaching	25 797	195	7.6	256	9.9	110	4.24	0.561	0.427	0.666	0.456	0.507	0.347
Croydon	30 581	231	7.5	303	9.9	72	2.35	0.312	0.238	0.384	0.240	0.292	0.183
Cumbria Teaching	34 669	256	7.4	336	9.7	216	6.23	0.844	0.642	0.956	0.732	0.727	0.557
Darlington	8 312	62	7.5	82	9.9	34	4.09	0.545	0.415	0.728	0.362	0.554	0.276
Derby City	20 048	151	7.5	198	9.9	119	5.94	0.789	0.600	0.930	0.648	0.708	0.493
Derbyshire County	53 933	399	7.4	524	9.7	232	4.30	0.582	0.443	0.657	0.507	0.500	0.386
Devon	51 396	377	7.3	496	9.7	354	6.89	0.938	0.714	1.035	0.841	0.788	0.640
Doncaster	23 489	175	7.5	230	9.8	124	5.28	0.707	0.538	0.831	0.583	0.633	0.444
Dorset	27 413	201	7.3	264	9.6	66	2.39	0.326	0.248	0.405	0.247	0.308	0.188
Dudley	24 365	181	7.4	238	9.8	135	5.54	0.745	0.567	0.871	0.620	0.663	0.472
Ealing	27 174	210	7.7	276	10.1	42	1.55	0.200	0.152	0.261	0.140	0.199	0.106
East Lancashire Teaching	32 177	238	7.4	313	9.7	465	14.45	1.951	1.485	2.127	1.775	1.619	1.351
East Riding of Yorkshire	25 693	189	7.4	249	9.7	144	5.60	0.760	0.578	0.884	0.636	0.673	0.484
East Sussex Downs and Weald	24 318	178	7.3	234	9.6	95	3.91	0.533	0.406	0.640	0.426	0.487	0.324
Eastern and Coastal Kent	48 493	358	7.4	471	9.7	132	2.71	0.367	0.279	0.429	0.304	0.327	0.231
Enfield	35 288	266	7.5	349	9.9	271	7.68	1.020	0.776	1.141	0.899	0.868	0.684
Gateshead	18 147	136	7.5	179	9.9	48	2.62	0.349	0.266	0.448	0.250	0.341	0.190
Gloucestershire	37 128	273	7.3	359	9.7	77	2.06	0.280	0.213	0.343	0.218	0.261	0.166
Great Yarmouth and Waveney	22 709	169	7.4	222	9.8	130	5.72	0.771	0.587	0.903	0.639	0.687	0.486
Greenwich Teaching	19 740	151	7.7	199	10.1	86	4.33	0.566	0.431	0.686	0.446	0.522	0.340
Halton and St Helens	23 827	179	7.5	235	9.9	51	2.14	0.285	0.217	0.363	0.207	0.276	0.157
Hammersmith and Fulham	15 833	120	7.6	158	10.0	96	6.06	0.798	0.607	0.957	0.639	0.728	0.486
Hampshire	79 497	586	7.4	770	9.7	36	0.45	0.061	0.047	0.081	0.041	0.062	0.031
Haringey Teaching	41 148	311	7.6	409	9.9	346	8.41	1.112	0.846	1.228	0.995	0.934	0.757
Harrow	19 617	149	7.6	196	10.0	18	.89	0.117	0.089	0.172	0.062	0.131	0.047
Hartlepool	10 786	81	7.5	106	9.9	18	1.62	0.216	0.165	0.318	0.115	0.242	0.088
Hastings and Rother	11 403	84	7.4	110	9.7	25	2.19	0.298	0.226	0.414	0.181	0.315	0.138
Havering	16 833	125	7.4	164	9.7	50	2.94	0.397	0.302	0.507	0.286	0.386	0.218
Heart of Birmingham Teaching	27 867	211	7.6	278	10.0	40	1.44	0.189	0.144	0.248	0.131	0.189	0.099
Herefordshire	17 538	130	7.4	171	9.8	89	5.07	0.683	0.520	0.825	0.542	0.628	0.412
Hertfordshire (PCT East and North; West Hertf.)	72 470	539	7.4	708	9.8	117	1.61	0.217	0.165	0.257	0.178	0.195	0.135
Heywood, Middleton, and Rochdale	37 900	284	7.5	374	9.9	48	1.27	0.169	0.129	0.217	0.121	0.165	0.092
Hillingdon	21 929	165	7.5	217	9.9	42	1.89	0.251	0.191	0.327	0.175	0.249	0.133
Hounslow	21 237	164	7.7	215	10.1	50	2.33	0.303	0.230	0.387	0.218	0.294	0.166

(*continued*)

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Table III. Continued

PCT	Population 2-8 y, 2007-2010	Expected 2007-2010 (annual average) for +25 dB Number	Rate	for +20 dB Number	Rate	Observed 2007-2010 (annual average) Number	Rate	O:E 25 bB O:E ratio	20 dB O:E ratio	O:E 95% CIs for +25 dB upper 95% CI	lower 95% CI	for +20 dB upper 95% CI	lower 95% CI
Hull Teaching	20 146	153	7.6	201	10.0	125	6.20	0.816	0.621	0.958	0.673	0.729	0.512
Isle of Wight National Health Service	12 047	90	7.5	118	9.8	26	2.16	0.290	0.220	0.401	0.178	0.305	0.136
Islington	12 410	95	7.6	124	10.0	23	1.85	0.243	0.185	0.343	0.144	0.261	0.110
Kensington and Chelsea	12 993	97	7.5	128	9.8	19	1.42	0.190	0.145	0.277	0.103	0.210	0.079
Kingston	12 885	97	7.5	127	9.9	66	5.08	0.676	0.514	0.839	0.513	0.638	0.390
Kirklees	30 182	226	7.5	297	9.8	171	5.67	0.756	0.575	0.869	0.643	0.661	0.489
Knowsley	18 760	140	7.5	184	9.8	56	2.99	0.399	0.304	0.503	0.295	0.383	0.224
Lambeth	20 160	156	7.7	205	10.2	25	1.24	0.161	0.122	0.223	0.098	0.170	0.074
Leeds	47 841	360	7.5	473	9.9	279	5.83	0.775	0.590	0.866	0.684	0.659	0.521
Leicester City	35 409	269	7.6	354	10.0	156	4.41	0.580	0.441	0.670	0.489	0.510	0.372
Leicestershire County and Rutland	46 092	341	7.4	449	9.7	310	6.73	0.908	0.691	1.009	0.807	0.767	0.614
Lewisham	30 527	231	7.6	303	9.9	55	1.79	0.236	0.180	0.299	0.173	0.227	0.132
Lincolnshire Teaching	43 198	320	7.4	420	9.7	214	4.95	0.669	0.509	0.759	0.580	0.577	0.441
Liverpool	36 432	273	7.5	359	9.9	98	2.69	0.359	0.273	0.430	0.288	0.327	0.219
Luton	22 492	171	7.6	225	10.0	87	3.85	0.505	0.384	0.611	0.399	0.465	0.303
Manchester Teaching	33 141	256	7.7	336	10.1	140	4.22	0.547	0.417	0.638	0.457	0.485	0.348
Medway	26 516	200	7.5	263	9.9	93	3.49	0.463	0.352	0.557	0.369	0.424	0.281
Mid Essex	28 169	208	7.4	274	9.7	149	5.29	0.715	0.544	0.830	0.601	0.632	0.457
Middlesbrough	16 463	123	7.5	162	9.8	57	3.43	0.458	0.349	0.578	0.339	0.440	0.258
Milton Keynes	19 847	150	7.5	197	9.9	100	5.04	0.668	0.509	0.799	0.538	0.608	0.409
Newcastle	20 488	154	7.5	202	9.9	96	4.69	0.624	0.475	0.749	0.500	0.570	0.380
Newham	25 195	196	7.8	257	10.2	74	2.94	0.378	0.288	0.465	0.292	0.353	0.222
Norfolk	46 473	346	7.5	455	9.8	241	5.19	0.696	0.530	0.784	0.608	0.596	0.463
North East Essex	30 659	227	7.4	298	9.7	114	3.70	0.500	0.380	0.592	0.408	0.450	0.310
North East Lincolnshire	15 379	115	7.4	151	9.8	33	2.11	0.284	0.216	0.381	0.186	0.290	0.142
North Lancashire Teaching	19 517	143	7.3	188	9.6	84	4.28	0.584	0.444	0.709	0.459	0.539	0.349
North Lincolnshire	14 656	109	7.4	143	9.8	33	2.25	0.303	0.230	0.406	0.200	0.309	0.152
North Somerset	15 102	112	7.4	147	9.7	47	3.11	0.421	0.320	0.541	0.301	0.411	0.229
North Staffordshire	15 371	113	7.4	149	9.7	22	1.43	0.195	0.148	0.276	0.113	0.210	0.086
North Tyneside	14 820	111	7.5	146	9.8	97	6.51	0.871	0.662	1.044	0.697	0.794	0.531
North Yorkshire and York	45 510	336	7.4	442	9.7	120	2.64	0.357	0.271	0.420	0.293	0.320	0.223
Northamptonshire Teaching	57 534	428	7.4	563	9.8	288	5.01	0.673	0.512	0.750	0.595	0.571	0.453
Northumberland	31 739	235	7.4	309	9.7	264	8.32	1.123	0.855	1.258	0.988	0.957	0.752
Nottingham City	21 519	163	7.6	214	10.0	173	8.04	1.062	0.808	1.219	0.904	0.928	0.688
Nottinghamshire County Teaching	42 661	317	7.4	417	9.8	91	2.12	0.285	0.217	0.344	0.226	0.262	0.172
Oldham	28 553	213	7.5	280	9.8	245	8.58	1.148	0.874	1.291	1.005	0.983	0.765
Oxfordshire	41 870	313	7.5	411	9.8	102	2.44	0.326	0.248	0.389	0.263	0.296	0.200
Peterborough	24 121	182	7.5	239	9.9	170	7.05	0.935	0.711	1.075	0.795	0.818	0.605
Plymouth Teaching	17 743	134	7.6	176	9.9	42	2.34	0.310	0.236	0.404	0.216	0.307	0.164
Portsmouth City Teaching	15 601	117	7.5	154	9.9	112	7.18	0.954	0.726	1.130	0.778	0.859	0.592
Redbridge	22 203	168	7.6	221	9.9	43	1.94	0.256	0.195	0.333	0.180	0.253	0.137
Redcar and Cleveland	14 654	109	7.4	143	9.8	61	4.16	0.559	0.425	0.699	0.419	0.532	0.319
Richmond and Twickenham	15 170	113	7.4	148	9.8	49	3.23	0.434	0.330	0.555	0.312	0.422	0.238
Rotherham	19 653	146	7.4	192	9.8	42	2.11	0.284	0.216	0.370	0.198	0.282	0.150
Salford	18 096	137	7.6	180	10.0	53	2.93	0.386	0.294	0.490	0.282	0.373	0.215
Sandwell	24 242	183	7.6	241	9.9	66	2.72	0.360	0.274	0.447	0.273	0.340	0.208
Sefton	21 661	161	7.4	211	9.8	62	2.84	0.382	0.291	0.478	0.287	0.363	0.218
Sheffield	34 390	257	7.5	338	9.8	59	1.72	0.229	0.174	0.288	0.171	0.219	0.130
Shropshire County	26 001	193	7.4	253	9.7	207	7.96	1.075	0.818	1.220	0.929	0.929	0.707
Solihull	17 348	128	7.4	168	9.7	112	6.46	0.878	0.668	1.041	0.716	0.792	0.545
Somerset	32 906	242	7.4	318	9.7	50	1.50	0.205	0.156	0.261	0.148	0.199	0.112
South Birmingham	29 896	224	7.5	295	9.9	162	5.42	0.722	0.550	0.833	0.611	0.634	0.465
SouthEastEssex	26 653	198	7.4	261	9.8	159	5.97	0.801	0.609	0.925	0.677	0.704	0.515
SouthGloucestershire	21 942	162	7.4	213	9.7	75	3.40	0.459	0.349	0.563	0.355	0.428	0.270
SouthStaffordshire	39 796	294	7.4	386	9.7	61	1.53	0.207	0.158	0.259	0.155	0.197	0.118
SouthTyneside	19 724	147	7.4	193	9.8	207	10.50	1.412	1.074	1.604	1.221	1.220	0.929
SouthWestEssex	28 837	215	7.5	283	9.8	68	2.36	0.316	0.241	0.391	0.241	0.298	0.183
SouthamptonCity	20 999	159	7.6	209	9.9	127	6.05	0.800	0.609	0.939	0.661	0.714	0.503
Southwark	21 205	165	7.8	217	10.2	34	1.60	0.206	0.157	0.275	0.137	0.209	0.104
Stockport	22 557	169	7.5	222	9.8	22	0.98	0.130	0.099	0.185	0.076	0.141	0.058
Stockton-on-TeesTeaching(PCTNorthTees)	17 089	128	7.5	168	9.8	93	5.44	0.729	0.555	0.877	0.581	0.667	0.442
StokeonTrent	18 945	143	7.6	188	9.9	61	3.19	0.423	0.322	0.529	0.316	0.403	0.241
Suffolk	40 633	303	7.5	398	9.8	277	6.82	0.914	0.696	1.021	0.807	0.777	0.614
SunderlandTeaching	27 429	204	7.5	269	9.8	94	3.43	0.460	0.350	0.553	0.367	0.420	0.279

(*continued*)

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Table III. Continued

PCT	Population 2-8 y, 2007-2010	Expected 2007-2010 (annual average) for +25 dB Number	Rate	Expected 2007-2010 (annual average) for +20 dB Number	Rate	Observed 2007-2010 (annual average) Number	Rate	O:E 25 bB O:E ratio	O:E 20 dB O:E ratio	O:E 95% CIs for +25 dB upper 95% CI	lower 95% CI	O:E 95% CIs for +20 dB upper 95% CI	lower 95% CI
Surrey	73 089	543	7.4	713	9.8	446	6.10	0.822	0.625	0.898	0.746	0.683	0.567
SuttonandMerton	48 006	360	7.5	473	9.9	95	1.97	0.262	0.200	0.315	0.210	0.240	0.159
Swindon	21 459	163	7.6	214	10.0	33	1.54	0.203	0.154	0.272	0.134	0.207	0.102
TamesideandGlossop	19 620	147	7.5	193	9.8	79	4.03	0.537	0.409	0.656	0.419	0.499	0.319
TelfordandWrekin	15 765	118	7.5	155	9.8	88	5.58	0.748	0.569	0.904	0.592	0.688	0.451
Torbay	10 401	77	7.4	102	9.8	68	6.54	0.878	0.668	1.086	0.670	0.826	0.510
TowerHamlets	17 958	138	7.7	182	10.1	72	3.98	0.517	0.394	0.637	0.398	0.485	0.303
Trafford	19 392	146	7.5	192	9.9	90	4.62	0.614	0.467	0.741	0.487	0.564	0.371
Wakefield District	23 506	175	7.4	230	9.8	76	3.21	0.432	0.329	0.529	0.335	0.403	0.255
Walsall Teaching	23 499	176	7.5	231	9.8	88	3.72	0.498	0.379	0.602	0.394	0.458	0.300
Waltham Forest	22 069	169	7.7	223	10.1	48	2.15	0.280	0.213	0.360	0.201	0.274	0.153
Wandsworth	22 052	172	7.8	226	10.2	57	2.58	0.331	0.252	0.417	0.246	0.318	0.187
Warrington	17 896	134	7.5	177	9.9	62	3.46	0.461	0.351	0.576	0.347	0.438	0.264
Warwickshire	34 692	257	7.4	337	9.7	135	3.89	0.526	0.400	0.615	0.438	0.468	0.333
WestEssex	28 160	209	7.4	275	9.8	95	3.37	0.454	0.346	0.545	0.363	0.415	0.276
West Kent	48 555	360	7.4	474	9.8	241	4.96	0.669	0.509	0.753	0.584	0.573	0.445
West Sussex	59 676	441	7.4	580	9.7	270	4.52	0.612	0.466	0.685	0.539	0.521	0.410
Western Cheshire	28 231	209	7.4	275	9.8	90	3.19	0.430	0.327	0.518	0.341	0.394	0.259
Westminster	15 265	116	7.6	152	10.0	29	1.90	0.250	0.190	0.341	0.159	0.260	0.121
Wiltshire	31 893	234	7.3	308	9.6	72	2.26	0.308	0.234	0.379	0.237	0.288	0.180
Wirral	27 820	207	7.4	272	9.8	120	4.30	0.578	0.440	0.682	0.475	0.519	0.361
Wolverhampton City	21 186	159	7.5	209	9.9	82	3.85	0.511	0.389	0.622	0.401	0.473	0.305
Worcestershire	36 964	274	7.4	360	9.8	151	4.09	0.551	0.419	0.638	0.463	0.486	0.352
Total	4 137 795	30 949	7.4	40 676	9.8	16 604	4.01	–3.36					

All rates per 1000 child-years.

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