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HEAD AND NECK

Hospital admissions for acute throat and deep neck infections versus tonsillectomy rates in Germany

Jochen P. Windfuhr[1] · **Yue-Shih Chen**[2]

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Abstract

Purpose To evaluate trends in hospital admissions in Germany for acute infections of the upper airway and deep neck in the context of the number of tonsil-related surgical procedures between 2005 and 2017.

Methods A retrospective longitudinal population-based cohort study was performed including all unplanned admissions for acute pharyngitis/tonsillitis, abscess formation of the peritonsillar or retropharyngeal/parapharyngeal space. Elective procedures included tonsillectomy (with or without adenoidectomy), secondary tonsillectomy, and tonsillotomy. Emergency operations encompassed abscess-tonsillectomy and transoral drainage procedures of the peritonsillar/parapharyngeal/retropharyngeal space.

Results 553.600 admissions were registered in total with a significant, stepwise increase between 2005 and 2017, including retropharyngeal/parapharyngeal abscess (47.0%), acute tonsillitis (30.8%), acute pharyngitis (26.5%) and peritonsillar abscess (7.9%). There were 1.323.984 elective operations with a significant decrease during the study period. A total of 188.316 emergency operations were done, a significant decrease in the number of abscess-tonsillectomies was compensated by the increased number of transoral peritonsillar abscess drainages. The number of transoral parapharyngeal and retropharygeal abscess drainage procedures did not change significantly ($p = 0.846$; $p = 0.846$). Negative correlation was significant between admissions for chronic tonsillitis and emergency admissions (Pearson correlation coefficient $= -0.879$, $p < 0.001$) and also between elective and emergency operations ($r = -0.667$; $p = 0.013$).

Conclusions Concerning infections of the upper airway and deep neck spaces, German Hospitals have to prepare strategies for the increasing challenge by unplanned admissions and emergency operations. Further research is required to clarify whether this phenomenon is caused by the significant decrease in the number of elective operations.

Keywords Tonsillectomy · Tonsillotomy · Tonsillitis · Pharyngitis · Abscess · Tonsil

Introduction

Typical indications for tonsillotomy (TT) and tonsillectomy (TE) include recurrent episodes of acute tonsillitis and/or upper airway obstruction due to tonsillar hyperplasia, at least in the pediatric patient population [1]. Despite repeated publication of a guideline for the management of sore throat, few children with evidence-based indications underwent TE in the UK and a significant proportion who did was unlikely to benefit [2]. Evidence is given from recent research that TE in general is less frequently performed in various states, either of the European Union [3] or the OECD [4]. The reasons may vary across countries and the debate about the value of TT or TE has not yet come to an end. However, cost-driven and unselected restrictions in the UK were accompanied by rising rates of hospital admissions for upper airway infections [5, 6]. A guideline for the management of tonsillitis was published in Germany in 2015, where the number of annually performed tonsillectomies had decreased beforehand [7]. This study was undertaken to longitudinally evaluate trends in hospital admissions in Germany for acute infections of the upper airway and deep neck space in the context of the number of tonsil-related surgical procedures performed.

✉ Jochen P. Windfuhr
jochen.windfuhr@mariahilf.de

[1] Department of Otorhinolaryngology, Plastic Head and Neck Surgery, Kliniken Maria Hilf, Viersener Str. 450, 41063 Mönchengladbach, Germany

[2] Private Practice, Bad Honnef, Germany

Materials and methods

An observational longitudinal study of the population of Germany was performed with the use of anonymous, open-access population data [8–10]. Moreover, a bespoke report was commissioned by the authors from the Federal Office for Statistics. The database was interrogated for all episodes of inpatient activity within German hospitals, including unplanned admissions for acute pharyngitis (code J02), acute streptococci-associated pharyngitis (code J02.0), acute tonsillitis (code J03), streptococci-associated tonsillitis (code J03.0), peritonsillar abscess (PTA; code J36), retropharyngeal abscess (RPA) and parapharyngeal abscess (PPA; code J39 for both) as well as planned admissions for chronic tonsillitis (J35.0), tonsillar hypertrophy with (J35.3) or without (J35.1) adenoids, respectively. The database did not include patients seen within primary care or cases treated on an outpatient basis. Furthermore, the study population included all patients who had undergone surgery on an inpatient basis in Germany. Indication for surgery was an invalid search criterion. Elective procedures included TE (code 5-281.0), secondary TE (STE; 5-281.4), tonsillectomy with adenoidectomy (ATE; code 5-282.0), tonsillotomy (TT; code 5-281.5; introduced in 2007) and emergency operations encompassed abscess-TE (ABTE; code 5-281.1), transoral drainage of either peritonsillar (code 5-280.0), parapharyngeal (code 5-280.1) or retropharyngeal abscess (code 5-280.1), respectively. We calculated admission and operation rates for each calendar year as the total number of admissions or operations divided by the end-year population number according to the German Federal Office of Statistics published for an 82-million nation [8, 9].

Descriptive statistics (Microsoft, Excel) was completed using two-sided Chi-square test to detect differences throughout the study period either for diagnosis or surgical procedures. Pearson's correlation coefficient was calculated to detect the correlation between elective and emergency diagnosis as well as elective and emergency procedures using SPSS V 25 for Windows. p values < 0.05 were considered significant. The study was exempt from ethic approval according §15 of the Professional Code of Conduct of the regional Medical Association (Nordrhein).

Results

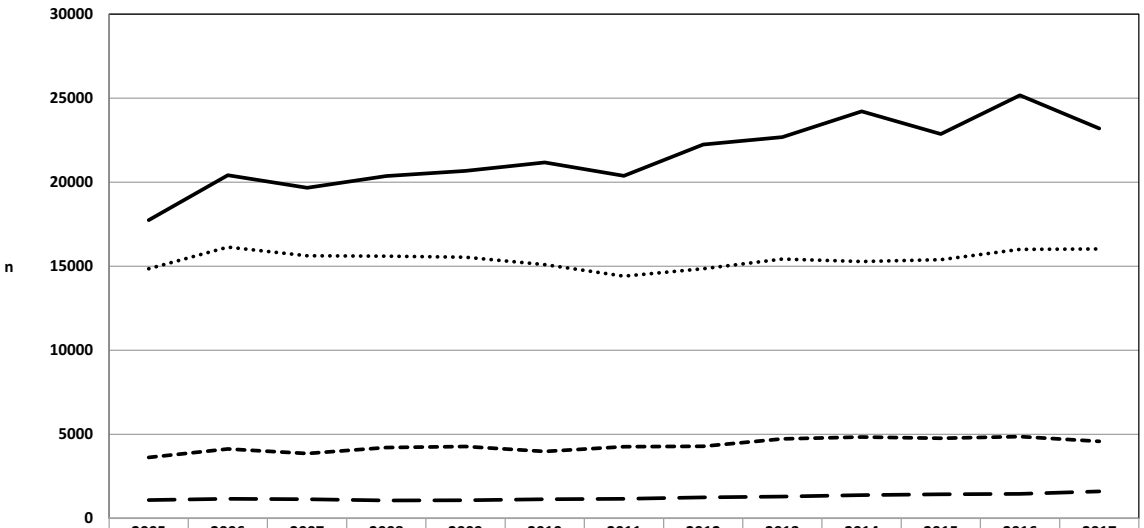
A total number of 553.600 admissions was registered within the study period including acute pharyngitis ($n = 56.400$, associated with streptococci in 3.284 cases), acute tonsillitis ($n = 280.747$, associated with streptococci in 44.581 cases), PTA ($n = 200.209$) and RPA/PPA ($n = 16.244$). Within the study period, there was a stepwise increase in the total number of emergency cases admitted for infections of the upper airway or deep neck between (+ 21.7%). The strongest increase was registered for RPA/PPA (47.0%), acute tonsillitis (30.8%) and acute pharyngitis (26.5%) and less evident for PTA (7.9%; Fig. 1). Results for streptococci-associated diseases were heterogeneous: the number of pharyngitis had *decreased* by 12.8% but the number of tonsillitis *increased* by 20.1% (data not shown). The number of elective admissions for chronic tonsillitis (− 58.3%) and tonsillar hypertrophy with adenoids had decreased (− 27.2%) while the number of patients with tonsillar hypertrophy without adenoids had increased by 15.1%) within the study period (Fig. 2). Figures 1 and 2 illustrate the relevance of the different diseases with emphasis on acute and chronic tonsillitis.

Data for surgical procedures were available only since 2005. A total of 1.538.443 procedures was performed between 2005 and 2017 including 815.299 TEs, 377.469 ATEs, 128.762 ABTEs, 120.681 TTs, 45.154 transoral PTA drainages, 12.050 transoral RPA/PPA drainages, 10.534 STEs, and 2.350 transoral retropharyngeal abscess drainages, respectively. Numbers in elective surgery considerably decreased within the study period (− 45.4%), including ATE (− 71.0%), TE (− 54.5%), and STE (− 48.8%). Contrary to this finding, a strong increase in the number of procedures was registered for TT (+ 282.0%; Fig. 3). The number of emergency operations had increased within the study period by 15.1%, including transoral drainage of the peritonsillar (+ 140%), parapharyngeal (+ 126%), and retropharyngeal (98.6%) space. Contrary to this, the number of ABTE had *declined* by 20% (Fig. 4).

Within the study period, the total rates per 100.000 considerably decreased for elective activities (operations: − 45.7%; admissions: − 48.6%) which contrasts with an increase in emergency activities (operations: + 14.6%; admissions: + 21.2%; Fig. 5).

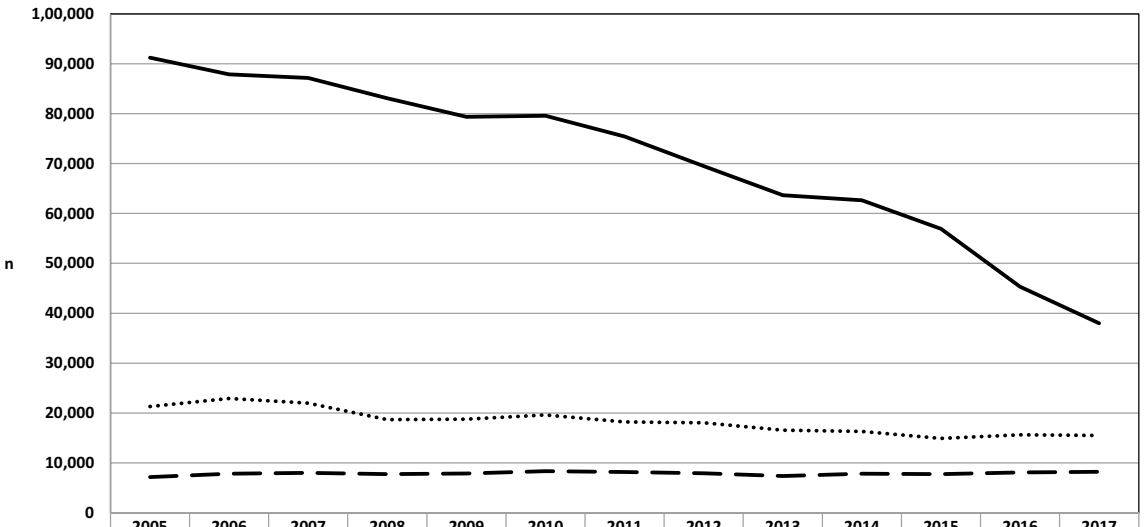
During the entire study period, the relation of all diseases—with the exception of acute tonsillitis (J03)—to particular age groups remained unchanged: pharyngitis (J02) was clearly related to young patients (< 15 years of age) as were diseases associated with streptococci (J02.0; J03.0). PTA predominantly occurred in young adults (15–45 years), RPA/PPA was almost evenly distributed across age groups. In contrast, rates of tonsillitis decreased in young patients (< 15 years) but increased in young adults (15–45 years; Table 1).

Mean length of hospitalization (in days) for the different entities had decreased in all of them. With the exception of streptococci-related pharyngitis, the number of patients who were treated for 1–3 days had increased in all diseases. Day cases (< 24 h hospitalization) had increased



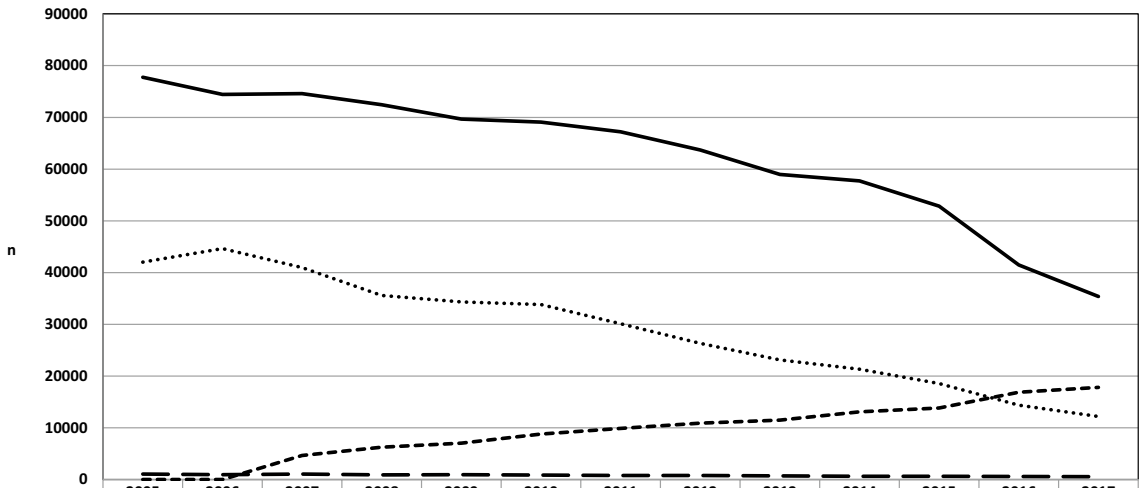
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
J 02	3621	4129	3853	4217	4269	3981	4267	4285	4730	4839	4766	4862	4581
J 03	17740	20406	19665	20362	20664	21171	20377	22239	22684	24208	22868	25166	23197
J 36	14845	16136	15625	15596	15532	15092	14414	14847	15422	15280	15393	16006	16021
J 39.0	1091	1162	1132	1064	1071	1141	1166	1246	1298	1387	1426	1456	1604

Fig. 1 Number of emergency hospital admissions related to the tonsils in Germany, 2005–2017. Within the study period, there was a stepwise increase in the total number of emergency cases admitted for infections of the upper airway or deep neck between (+21.7%). Patients were predominantly admitted for acute tonsillitis (J03), less frequently for acute pharyngitis (J02), peritonsillar abscess (J36) or retro/parapharyngeal abscess (J39). The strongest increase was registered for latter (+47.0%), but also for acute tonsillitis (+30.8%) and pharyngitis (+26.5%) Only a small increase was registered for peritonsillar abscess (+7.9%)



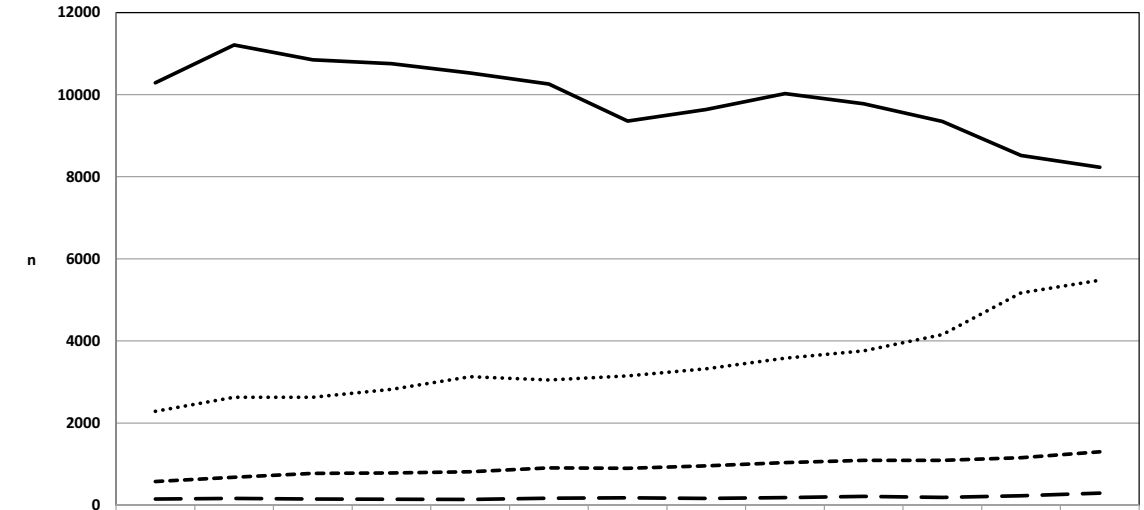
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
J35.0	91,196	87,866	87,146	83,083	79,356	79,561	75,416	69,492	63,644	62,637	56,918	45,329	37,991
J35.1	7,155	7,832	8,001	7,754	7,901	8,373	8,192	7,952	7,406	7,858	7,775	8,099	8,238
J35.3	21,310	22,944	21,979	18,675	18,763	19,613	18,237	18,053	16,574	16,320	14,927	15,636	15,516

Fig. 2 Number of elective hospital admissions related to the tonsils in Germany, 2005–2017. There was a large decline in the number of elective admissions for chronic tonsillitis (J35.0; −58.3%) and to a lesser extent for patients admitted for tonsillar hypertrophy with adenoids (J35.3; −27.2%). However, the number of patients admitted for tonsillar hypertrophy had increased by 15.1% (J35.1; −15.1%)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
TE	77765	74453	74594	72431	69666	69091	67217	63702	58955	57724	52841	41465	35395
ATE	42043	44655	40968	35584	34340	33836	30112	26339	23144	21319	18565	14367	12197
TOTO	0	0	4659	6258	7025	8799	9890	10925	11493	13111	13832	16880	17809
Re-TE	1080	966	1076	919	931	861	811	775	711	622	629	601	553

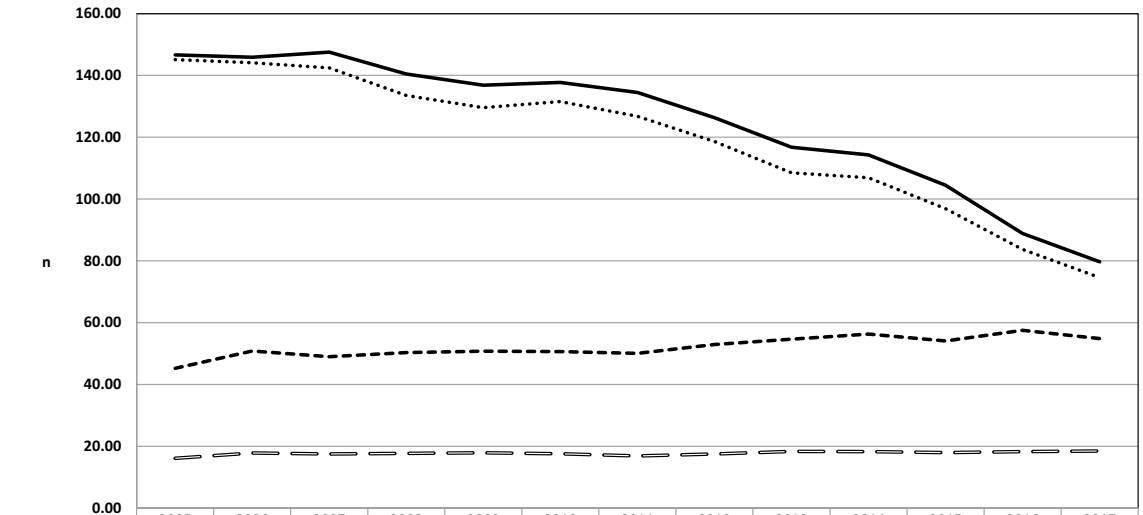
Fig. 3 Number of elective surgical procedures related to the tonsils in Germany, 2005–2017. With the exception for tonsillotomy (TT; +282%), the numbers considerably decreased within the study period not only including tonsillectomy with (ATE; −71.0%) or without adenoidectomy (TE; −54.5%) but also for secondary tonsillectomy to remove tonsillar remnants (Re-TE; −48.8%)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
5-281.1	10286	11209	10846	10754	10524	10259	9353	9636	10026	9776	9344	8518	8231
5-280.0	2283	2626	2629	2823	3130	3049	3150	3321	3581	3758	4156	5172	5476
5-280.1	574	678	772	784	815	909	895	958	1035	1089	1089	1155	1297
5-280.2	147	163	147	144	140	166	178	162	182	212	187	230	292

Fig. 4 Number of emergency operations related to the tonsils in Germany, 2005–2017. The total number of emergency operations had increased within the study period by 15.1%, including transoral drainage of the peritonsillar (5-280.0; +140%), parapharyngeal (5-280.1; +126%) and retropharyngeal (5-280.2; +98.6%) space. Contrary to this, the number of abscess-tonsillectomies (5-281.1) had *declined* by 20%

constantly in patients with tonsillitis, pharyngitis and PTA. A stepwise increase was registered for patients with RPA/PPA and streptococci-related tonsillitis. No clear trend was obtainable from the data for streptococci-related pharyngitis. Occasional deaths had occurred only after tonsillitis, pharyngitis and peritonsillar abscess during the study period (Table 2).



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
elect OP	146.64	145.87	147.53	140.47	136.87	137.72	134.49	126.35	116.76	114.26	104.49	88.84	79.66
elect adm	145.15	144.13	142.46	133.55	129.61	131.55	126.79	118.59	108.49	106.92	96.89	83.69	74.58
emerg OP	16.12	17.83	17.51	17.69	17.86	17.59	16.90	17.48	18.35	18.27	17.98	18.27	18.48
emerg adm	45.24	50.82	48.99	50.29	50.78	50.62	50.07	52.92	54.64	56.30	54.10	57.55	54.84

Fig. 5 Total rates per 100.000 of inpatient procedures related to the tonsils in Germany, 2005–2017. Within the study period, the total rates considerably decreased for elective operations (elect OP; − 45.7%) and admissions (elect adm: −48.6%). In contrast, the rates of emergency operations (emerg OP; +14.6%) and admissions (emerg adm: +21.2%) had increased, but to a lesser extent

All diseases predominantly had occurred in male patients in 2005, but the male-to-female ratio decreased (tonsillitis; pharyngitis), remained stable (PTA) or increased (RPA/PPA) during the study period. More females had undergone tonsil surgery in 2005 with a subsequent increase in the male-to-female ratio (Table 3).

Significant differences ($p < 0.001$) were found for all diagnosis categories and procedures except for 5–280.1 ($p = 0.846$) and 5–280.2 ($p = 0.846$). Negative correlation was strong between elective (J35, J35.1, J35.3) and emergency (J02, J03, J36, J39) diagnosis (Pearson correlation coefficient = −0.879, $p < 0.001$) and also significant between elective (5–281.0, 5–281.4, 5–281.5, 5–282.0) and emergency (5–280.0, 5–280.1, 5–280.2, 5–281.1) procedures ($r = -0.667$; $p = 0.013$).

Discussion

This longitudinal study covered a period of 13 years and compares well to other reports with a study period of 11 [11], 12 [12], 14 [5, 6], 15 [13], and 21 years [14], respectively. In contrast to most studies, we did not only register the number of TE/ATE, but also TT, STE, ABTE and transoral drainage operations in our research. In total, elective procedures had decreased by 45.4% (rate: minus 45.7%), emergency procedures to resolve abscess formation had increased by 15.1% (rate: plus 14.6%), unplanned hospital admissions had increased by 21.7% (rate: plus 21.2%) and planned hospital admissions had decreased by 48.4% (rate: 48.6%) within the study period.

All studies listed in Table 4 reported a dramatic decrease of TE rates associated and a significant increase of hospital admissions for sore throat. This was attributed by the authors to the implementation of the Scottish Intercollegiate Guidance Network (SIGN) on TE indications in 1999, with an update in 2010 [15]. This guideline was released in recognition that the management of sore throat is a significant burden on health resources and recommended watchful waiting for mild sore throats, and TE for recurrent severe sore throats with a specified number of episodes of recurrent sore throats required over different time periods to qualify a patient for TE based on expert opinion [5]. Moreover, some primary care trusts (PCTs) compiled lists of what they considered "procedures of low clinical effectiveness" including TE [14]. Subsequently, hospital admissions for sore throat had increased significantly in 2005/2006 and the authors stated that there was a strongest correlation with low TE rates in children 1–4 years of age [5]. Interestingly, a significant impact of the SIGN guideline on TE rates was assumed for England and Wales, but not for Scotland, emphasizing problems with guideline implementation. However, an increase in hospital admissions for acute tonsillitis was registered in all cohorts, but admission for PTA did not increase in Scotland, where a sharp decline of the overall TE rate after 1999 flattened out and became stable from 2002 [16].

Table 1 Infections of the upper airways and deep neck spaces

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
J02													
< 15 years	22	24	23	26	26	23	25	24	27	27	26	26	25
< 45 years	2	3	2	3	3	3	3	3	4	4	4	4	4
< 65 years	1	1	1	1	1	1	1	2	2	2	2	2	2
> 65 years	1	1	1	1	2	1	2	2	2	2	2	2	2
J02.0													
< 15 years	1	1	2	2	2	1	1	2	1	1	1	1	1
< 45 years	0	0	0	0	0	0	0	0	0	0	0	0	0
< 65 years	0	0	0	0	0	0	0	0	0	0	0	0	0
> 65 years	0	0	0	0	0	0	0	0	0	0	0	0	0
J03													
< 15 years	94	109	104	107	104	104	99	107	103	105	96	97	90
< 45 years	17	20	20	22	25	27	28	31	34	39	37	43	39
< 65 years	3	4	3	3	4	4	4	5	5	5	5	6	5
> 65 years	2	2	2	2	2	2	2	2	2	3	2	3	2
J03.0													
< 15 years	16	19	21	23	21	22	22	21	22	23	22	23	20
< 45 years	2	2	3	3	3	3	3	3	3	4	4	3	3
< 65 years	0	0	0	0	0	0	0	0	0	0	0	0	0
> 65 years	0	0	0	0	0	0	0	0	0	0	0	0	0
J36													
< 15 years	9	10	9	9	9	9	8	8	9	8	7	8	9
< 45 years	30	33	33	33	33	32	32	33	34	34	34	35	35
< 65 years	11	12	12	13	13	13	13	12	13	13	13	13	13
> 65 years	6	7	7	7	8	7	7	7	8	7	8	8	8
J39.0													
< 15 years	1	1	1	1	1	1	1	1	1	1	1	1	1
< 45 years	2	2	2	1	1	1	1	1	2	2	2	2	2
< 65 years	1	1	1	2	2	2	2	2	2	2	2	2	2
> 65 years	1	1	1	1	2	2	2	2	2	2	2	2	2

Age-specific rates per 100.000 in Germany 2005–2017

During the entire study period, the relation of all diseases—with the exception of acute tonsillitis (J03)—to particular age groups remained unchanged: pharyngitis (J02) was clearly related to young patients (< 15 years of age) as were diseases associated with streptococci (J02.0; J03.0). Peritonsillar abscess predominantly occurred in young adults (15–45 years), retropharyngeal/parapharyngeal abscess formation was almost evenly distributed across age groups. In contrast, rates of tonsillitis decreased in young patients (< 15 years) but increased in young adults (15–45 years)

J02 acute pharyngitis, *J02.0* acute streptococci-associated pharyngitis, *J03* acute tonsillitis, *J03.0* streptococci-associated tonsillitis, *J36* peritonsillar abscess, *J39* retro-/parapharyngeal abscess

It has been stated recently that there are twice as many annual hospital admissions related to throat infections than there are for TE in England [17]. The total number of TEs performed in England had dropped from 28.309 in 1990/14 to 6.327 in 2013/14. This finding is in accordance at least in part with all studies reporting a negative correlation of hospital admissions for sore throat and TE rates (Table 4), particularly in young children with proven infections due to (invasive) Group A β-hemolytic streptococci [5].

Streptococcus pyogenes bacteria still play a major role in acute tonsillitis [18]. In case of PPA, PTA or RPA, a combination with anaerobic bacteria such as *Peptostreptococci, Prevotella* and *Fusobacterium necrophorum* is common [19, 20]. However, contemporary recommendations for antibiotic therapy have not changed [20, 21] and bacteria involved in tonsil-related diseases were not labeled by the WHO to be resistant to antibiotics [22]. Increased hospital admissions, therefore, do not result from inadequate antibiotic treatment.

Despite the dramatic decrease in the number of elective operations and the increased number of admissions for sore throat we were unable to detect comparable clear-cut

Table 2 Hospitalization length and deaths of the upper airway and deep neck space infections in Germany 2005–2017

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
J02													
1–3 days	2.314	2.663	2.546	2.895	2.901	2.810	3.071	2.972	3.398	3.463	3.451	3.519	3.430
< 1 days	84	94	77	99	121	97	106	107	113	128	150	132	140
Deaths	3	3	3	3	3	1	1	4	2	-	8	2	4
Mean (days)	3.3	3.3	3.3	3.1	3.1	3.1	3	3.1	3	3	2.9	2.9	2.8
J02.0													
1–3 days	121	130	193	173	182	163	149	158	172	167	158	145	134
< 1 days	2	4	2	6	10	3	2	6	3	1	2	5	4
Deaths	–	–	–	–	–	–	–	–	–	–	–	–	–
Mean (days)	3.9	3.7	3.9	3.7	3.5	3.5	3.4	3.2	3.2	3.3	3	3.4	3.1
J03													
1–3 days	8.843	10.795	10.382	11.346	11.802	12.270	12.225	13.539	14.039	15.231	14.757	16.468	15.333
< 1 days	199	207	226	296	317	313	332	359	353	388	401	454	405
Deaths	2	3	4	2	5	4	5	1	5	2	4	4	1
Mean (days)	4	3.9	3.9	3.7	3.6	3.6	3,6	3.5	3.4	3.4	3.3	3.3	3.2
J03.0													
1–3 days	1.494	1.851	2.124	2.260	2.201	2.327	2.255	2.273	2.330	2.570	2.513	2.644	2.333
< 1 days	23	19	31	47	46	38	36	37	33	49	43	50	41
Deaths	–	–	–	–	–	–	–	–	–	–	–	–	–
Mean (days)	3.7	3.6	3.7	3.5	3.5	3.4	3.3	3.3	3.3	3.2	3.1	3.1	3
J36													
1–3 days	3.132	3.465	3.402	3.403	3.711	3.666	3.731	3.936	4.136	4.372	4.889	5.934	5.998
< 1 days	77	89	86	96	97	96	97	97	100	101	115	128	108
Deaths	6	4	3	8	6	4	11	3	7	5	5	6	6
Mean (days)	5.6	5.5	5.5	5.4	5.3	5.2	5.1	5.1	5	4.9	4.8	4.6	4.5
J39.0													
1–3 days	225	244	211	175	209	212	193	223	209	245	247	272	284
< 1 days	18	8	16	21	24	25	26	33	31	27	23	28	35
Deaths	–	–	–	–	–	–	–	–	–	–	–	–	–
Mean (days)	7.1	7.6	7.7	7.9	7.6	7.4	7.9	7.6	7.9	7.8	7.8	7	7.1

Mean length of hospitalization (in days) for the different diseases had decreased in all of them. With the exception of streptococci-related pharyngitis, the number of patients who were treated for 1–3 days had increased in all diseases. Day cases (< 24 h hospitalization) had increased constantly in patients with tonsillitis, pharyngitis and peritonsillar abscess. A stepwise increase was registered for patients with retropharyngeal/parapharyngeal abscess formation and streptococci-related tonsillitis. No clear trend was obtainable from the data for streptococci-related pharyngitis. Deaths had occurred only after tonsillitis, pharyngitis and peritonsillar abscess but without a trend during the study period

J02 acute pharyngitis, *J02.0* acute streptococci-associated pharyngitis, *J03* acute tonsillitis, *J03.0* streptococci-associated tonsillitis, *J36* peritonsillar abscess, *J39* retro-/parapharyngeal abscess

changes after introduction of a German guideline for the management of sore throat [23] in 2009 and or the management of tonsillitis in 2015 [20, 24]. The number of elective operations was greater than the number of emergency operations plus conservative therapy in each year of our study. Moreover, the rise for sore throat admissions was 21.7% compared to a reduction of 54.5% for elective TE. In contrast to other authors, our study does not support the idea that lower TE rates are automatically followed by a dramatic increase in unplanned hospital admissions. This hypothesis is also challenged by variably falling TE and PTA rates but comparable admission rates for tonsillitis after introduction of the SIGN guidelines (Table 4). Hospital admissions may, therefore, not only result from surgical strategies but also referral patterns, population density, housing conditions, national health care systems, antibiotic prescribing practices, access to ENT specialists, virulence of infective organisms, patient social circumstances and decreasing attendance trend in primary care [5, 12, 16, 25–28].

A total of 699.898 TEs and 574,532 hospital admissions for acute tonsillitis (to be differentiated from acute throat infection, ATI; Table 4) were reported for England, Wales and Scotland between 1999 and 2010 [12]. The great number of admissions contrasts sharply to only 280.747 admissions

Table 3 Surgical procedures and infections of the upper airways and deep neck spaces: prevalence in male and female patients in Germany 2005–2017

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
J02													
m	1.903	2.158	1.962	2.207	2.158	2.032	2.252	2.175	2.445	2.509	2.436	2.533	2.282
f	1.718	1.971	1.891	2.010	2.111	1.949	2.015	2.110	2.285	2.330	2.330	2.329	2.299
m:f	1.11	1.09	1.04	1.10	1.02	1.04	1.12	1.03	1.07	1.08	1.05	1.09	0.99
J02.0													
m	114	142	180	169	146	121	127	141	126	123	107	125	85
f	105	105	171	129	136	132	100	118	125	130	116	105	106
m:f	1.09	1.35	1.05	1.31	1.07	0.92	1.27	1.19	1.01	0.95	0.92	1.19	0.80
J03													
m	9.534	10.929	10.252	10.695	10.858	11.005	10.482	11.527	11.631	12.205	11.742	12.869	11.623
f	8.206	9.477	9.413	9.666	9.806	10.166	9.895	10.712	11.053	12.003	11.126	12.297	11.574
m:f	1.16	1.15	1.09	1.11	1.11	1.08	1.06	1.08	1.05	1.02	1.06	1.05	1.00
J03.0													
m	1.417	1.632	1.877	1.973	1.817	1.832	1.800	1.759	1.795	1.883	1.875	1.912	1.643
f	1.254	1.495	1.717	1.696	1.700	1.740	1.611	1.680	1.662	1.794	1.674	1.779	1.564
m:f	1.13	1.09	1.09	1.16	1.07	1.05	1.12	1.05	1.08	1.05	1.12	1.07	1.05
J36													
m	8.436	9.273	8.873	8.870	8.769	8.607	8.271	8.520	8.846	8.977	8.876	9.134	9.184
f	6.409	6.863	6.752	6.726	6.763	6.485	6.143	6.327	6.576	6.303	6.517	6.872	6.837
m:f	1.32	1.35	1.31	1.32	1.30	1.33	1.35	1.35	1.35	1.42	1.36	1.33	1.34
J39.0													
m	634	688	694	638	646	704	734	744	760	855	854	893	1.002
f	457	474	438	426	425	437	432	502	538	532	572	563	602
m:f	1.39	1.45	1.58	1.50	1.52	1.61	1.70	1.48	1.41	1.61	1.49	1.59	1.66
Tonsillectomy procedures													
m	59.432	60.293	60.765	57.700	55.611	56.156	53.902	51.159	48.272	47.337	44.178	38.808	36.019
f	71.730	70.967	71.356	68.243	66.870	66.684	63.474	60.203	56.056	55.215	51.030	43.023	38.154
m:f	0.83	0.85	0.85	0.85	0.83	0.84	0.85	0.85	0.86	0.86	0.87	0.90	0.94

All diseases predominantly occurred in male patients in 2005 but the male-to-female ratio decreased (tonsillitis; pharyngitis), remained stable (PTA) or increased (RPA/PPA) during the study period. More females had undergone tonsil surgery in 2005 but the male-to-female ration increased within 12 years

in our study. Another conflicting result was identified for PTA: 96.682 admissions within 12 years vs. 200.209 admissions within 13 years in our study. Findings concerning age groups for admission for acute tonsillitis, PTA or TE were identical to our study and the number of 699.898 procedures (average population 64 million) appears comparable to 1.538.443 procedures within 13 years in Germany (average population 82 million).

Different findings were confirmed for young patients (< 18 years of age) for the same study period (1999–2010): a 76% linear increase in admission rates for sore throat, 40% increase of antibiotic prescribing (2000–2007), but stable admission rates for PTA and variable TE rates with an overall downward trend. Furthermore, the rising number of short-stay admissions was seen as a trend towards hospital treatment rather than in the community for sore throat, presumably reflecting lower thresholds for admission [11]. The statement is completely supported by the findings of our study: the number of short stays increased and the mean values for the length of stay declined for every single entity (Table 2).

However, a marked regional variation in both the TE rates and the size of reductions was also reported by Lau who identified greatest effects in the under-16 age group which contrasts with our results, at least for hospital admissions. He reported TE rates to have declined by 44% whereas the admission rate for tonsillitis had risen by 310% within 21 years in England. PTA as well as RPA/PPA admission rates had risen by 31% and 39% which contrasts sharply with our study (7.9%; 47%). Mean length of stay in 2010 was 0.9 for tonsillitis and 1.5 days for PTA which hardly compares to the results of our study (3.2 and 4.5 days, respectively; Table 3) [14]. Douglas reported a 66% overall decrease in length of stay for TE patients between 1993 and 2016 (TE:

Table 4 Numbers and rates of tonsillectomy, tonsillitis and deep neck infections in the literature

Author	Study period	Region	Study population	TE (total)	TE (rate)	TE m:f	Tonsillitis (total)	Tonsillitis (rate)	Tonsillitis m:f	PTA (total)	PTA (rate)	PTA m:f	RPA/PPA (total)	RPA/PPA (rate)	RPA/PPA m:f	Codes
Al-Hussaini	1999–2010	Scotland, Wales, England	All ages	699.898	88.9–105	1:1.43–1.54	574.532	77.6–122.0	1:1.1	96.682	13.5–17.0	1.3:1	ns	ns	ns	F34; J02; J36
Koshy	1999–2010	England	≤ 17 years	378.861	367.4–293.6	1.4–0.76:1	183.039 (ATI)	107.3–188.4	1.17–1.19:1	10.934	9.6–8.7	0.72–0.81:1	ns	ns	ns	F34; F36.3; J36; J02, J02.8, J02.9, J03.8, J03.9 = ATI; J00; J04; J05.0 (= viral upper respiratory tract infections)
Lau	1991–2011	England	All ages	ns	169–89	ns	ns	30–124	ns	ns	9–12	ns	ns	3–5	ns	F34; F36.3; J02; J03 (ICD-9: 034, 462, 463); J36 (ICD-9: 475); J39 (ICD-9: 478)
Yap	1999–2014	Wales	All ages	48.505	ns	ns	67,205	ns	ns	8.567	ns	ns	187	ns	ns	F34; J03.0; J03.8; J03.9; J36.X; J39.0
Douglas	1993–2016	Scotland	All ages	ns	165.4–86.7	ns	ns	114.6–270.1	ns	ns	2.4–6.4	ns	ns	ns	ns	F34; F36.3; J36 (ICD-9: 475); J02; J03 (ICD-9: 034, 462, 463); J39 (ICD-9: 478)

Table 4 (continued)

Author	Study period	Region	Study population	TE (total)	TE (rate)	TE m:f	Tonsillitis (total)	Tonsillitis (rate)	Tonsillitis m:f	PTA (total)	PTA (rate)	PTA m:f	RPA/PPA (total)	RPA/PPA (rate)	RPA/PPA m:f	Codes
McLeod	2000–2013	England, Wales, Australia, New Zealand	All ages	1.041.954	Only graphs	ns	846.111	Only graphs	ns	153.243	Only graphs	ns	ns	ns	ns	F34.1–9 without F34.6; J03; J36
Banigo	1991–2014	England	≤ 14 years	Only graphs	ns	ns	Only graphs	ns	ns	ns	ns	ns	ns	ns	ns	F34.00; F34.40; F34.80; J02; J03
This study	2005–2017	Germany	All ages	1.538.443	146.6–79.7	0.83–0.944:1	280.747 537.356 (ATI)	21.52–28.02	1.16–1.0:1	200.209	18.00–19.35	1.32–1.34:1	16.244	1.32–1.94	1.39–1.66:1	5-281.0; 5-281.1; 5-282.0; 5-281.5; 5-281.4; 5-280.0; 5-280.1; 5-280.2; J02; J02.0; J03.; J03.0; J36; J39.0; J35.0; J35.1; J35.3

Values for rates are provided for the beginning and the end of the individual study

ns not stated, *TE* tonsillectomy, *PTA* peritonsillar abscess, *RPA/PPA* retropharyngeal/parapharyngeal abscess, *ATI* acute throat infection, *m* male, *f* female, *F3440* tonsillectomy in adults, *F3480* tonsillectomy with adenoidectomy, *F3400* tonsillectomy in a child, *F34* excision of tonsil, *F34.1* bilateral dissection tonsillectomy, *F34.2* bilateral guillotine tonsillectomy, *F34.3* bilateral laser tonsillectomy, *F34.4* bilateral excision of tonsil NEC, *F34.5* excision of remnant of tonsil, *F34.6* excision of lingual tonsil, *F34.7* bilateral coblation tonsillectomy, *F34.8* other specified excision of tonsil, *5-281.0* tonsillectomy, *5-281.4* secondary tonsillectomy, *5-281.1* abscess-tonsillectomy, *5-282.0* tonsillectomy with adenoidectomy, *5-281.5* tonsillotomy, *5-280.0* transoral drainage of peritonsillar, parapharyngeal (5-280.1) or retropharyngeal (5-80.1) abscess, *Only graphs* number of individual procedures not provided

2.4 vs. 0.7 days; tonsillitis: 2.6 vs. 1.1 days; PTA: 2.6 vs. 1.1 days, respectively) indicating not only less severe sore throat diseases but also a different national strategy concerning TE patients.

Concerning hospital admissions, our study could not reveal dramatic changes in the age groups for various entities (Table 1), which was different in England [5]: the number of admissions for tonsillitis/pharyngitis had risen dramatically between 1990 and 2014 with the greatest increase (6.85-fold) in the over 15-year age group. The number of cases related to invasive Group A β-hemolytic streptococci had tripled in this age group, and had doubled in patients younger than 15 years of age. Deaths were not reported in other studies but had occurred in patients with acute tonsillitis, pharyngitis and PTA emphasizing the severity of these entities. Unfortunately, details were not obtainable from the database of the Federal Office of Statistics. Although RPA/PPAs are commonly acknowledged as more dangerous, deaths did not occur in our study. Male-to-female ratios were completely or in part different to other studies (Table 4). With the exception for PTA, a trend of change was proven for every entity (Table 3).

Unfortunately, the database of our study was not suitable to evaluate indications for elective operations on a patient level. However, the annual number of TE/ATE in patients younger than 15 years of age had decreased by 66% in Germany within the study period [29] (data not shown). Increasing rates of TT indicate that this procedure is gradually replacing ATE at least in the pediatric patient population. In this age group, upper airway obstruction is more common than tonsillitis as indication for surgery. This statement is supported by the finding, that in 2004, 68% of TEs were for tonsillitis, whereas in 2014, only 14.3% of TEs listed tonsillitis as the indication for tonsil surgery in England [5].

Conclusions

Only few large-scale studies evaluated the correlation between falling TE numbers and increasing numbers of sore throat admissions. While some authors accept the rise of hospital admission as a consequence of falling TE rates, some do not. Although we have to accept limitations of our retrospective study with presumably thousands of outpatient operations ignored, we agree with the latter. It is worth to repeat that the commonly performed linear regression models in the aforementioned studies were designed to show a correlation between two variables, but not causation. It might suggest that the rise in tonsillitis is positively correlated to the rise in peritonsillar and deep neck abscesses. It is not designed to prove that the increase in tonsillitis cases causes an increase in the incidence of PTA and deep neck abscess. Correlation may exist, but it can also be a coincidence by chance [30]. Cause and consequences cannot be distinguished with this statistical method. The same could be said about the correlation of infection and operation rates [13]. It should be emphasized that all studies accepted PTA, PPA, and RPA as a complication of tonsillitis, although this is not supported by scientific papers [31]. Moreover, all studies draw conclusions based on the basis of large-scale populations, not on patient level. In addition, the studies do not distinguish between hospital admissions for viral or bacterial infections. It should also be noted that our study—like any other—could not ascertain if patients who were admitted for sore throat had previously undergone TE.

It has also to be mentioned that the introduction of the Scottish Reduction in Antibiotic Prescribing (ScRAP) apparently resulted in a significant decrease in all primary care antibiotic prescribing, but an increase in all secondary care prescribing thus supporting more a paradigm shift than a true increase of diseases [16]. Since primary care is significantly different in Germany, it appears plausible to focus further investigation on this topic. Regional variability of hospital admission and TE rates challenge the negative correlation of TE and admission for tonsillitis rates. In contrast to England and Wales, admission rates for tonsillitis as well as for TE rose at the same time [6]. Finally, recent research clearly demonstrated that characteristics of admissions have significantly changed, in particular short-stay admissions due to respiratory infections [32]. Presentation in emergency departments is highly influenced by expectation of patients challenging financial reimbursement if patients are not admitted [28]. Therefore, prospective modelling/epidemiological studies are required to quantify the excess risk for these patients and to determine the potential value of surgical intervention [5]

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Research involving human and animals This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical approval According to the policy of the IRB responsible for the authors, this study was exempt from ethical approval because it was a secondary analysis of a publicly available dataset with anonymous data.

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