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Changes in healthcare utilisation for paediatric tonsillectomy and adenoidectomy in the Netherlands: a population-based study

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Abstract

Objectives: Tonsillectomy and adenoidectomy in children are controversial subjects with large regional variation in surgical rates, partly explained by cultural differences and lack of high-quality evidence on indications for surgery. A quality of care cycle was executed on this topic in the Netherlands. The objective of this study was to estimate changes in healthcare utilisation for paediatric tonsil surgery in the Netherlands.

Methods: Population-based data on tonsillectomies and adenoidectomies in children up to age 10 were retrieved retrospectively from Dutch administrative databases between 2005 and 2018. A change point analysis was performed to detect the most pivotal change point in surgical rates. We performed univariate analyses to compare surgical patients' characteristics before and after the pivotalpoint . Impact on healthcare budget and societal costs were estimated using current prices and data from cost-effectiveness analyses.

Results: The annual number of adenotonsillectomies reduced by 10 952 procedures (−39%; from 129 per 10 000 children to 87 per 10 000 children) between 2005 and 2018, and the number of adenoidectomies by 14 757 procedures (−49%; from 138 per 10 000 children to 78 per 10 000 children). The most pivotal change point was observed around 2012, accompanied by small changes in patient selection for surgery before and after 2012. An estimated €5.3 million per year was saved on the healthcare budget and €10.4 million per year on societal costs.

Conclusion: The quality of care cycle resulted in fewer operations, with a concomitant reduction of costs. We suggest that part of these savings be invested in new research to maintain the quality of care cycle.

1 | INTRODUCTION

Tonsillectomy and adenoidectomy in children are controversial subjects with large international and regional variation in surgical rates.[1] This is partly explained by cultural differences, such as a preference for antibiotics over surgery and differences in availability of and accessibility to health care.[2] Furthermore, this might also be stimulated by lack of high-quality evidence on the effectiveness of these procedures.[3,4] While the Paradise criteria formulated well-substantiated indications for adenotonsillectomy in children with severe symptoms of throat infections,[5] the added value of surgery over watchful waiting remained unclear for children with milder symptoms. In 2004, the results of a Dutch randomised controlled trial showed that employing a watchful waiting policy in children with milder symptoms resulted in fewer adenotonsillectomies with similar clinical outcomes.[6] Subsequently, the Dutch Association of Otorhinolaryngology and Head and Neck Surgery (NVKNO) developed a multidisciplinary, evidence-based guideline on this topic advising to perform a watchful waiting strategy in children with milder illness of tonsillitis.[7] Activities to implement this guideline in clinical practice included a national meeting with discussion sessions, audits and lectures during the semi-annual congress of the NVKNO in November 2004 and April 2007. During the guideline development process, the guideline committee identified another important knowledge gap regarding the effectiveness of adenoidectomy for upper respiratory tract infections. Consequently, a randomised controlled trial was conducted about this topic in the Dutch situation,[8] providing evidence that employing a watchful waiting policy led to fewer adenoidectomies in children with similar clinical outcomes, which was presented at the NVKNO congress in April 2012. Accordingly, the above-mentioned guideline was revised and presented on the NVKNO congress in April 2014. Also, the guideline recommendations were incorporated in the "Wise Choices" as part of the Choosing Wisely Campaign in the Netherlands that was launched in 2016 to support patients in choosing evidence-based and necessary care.[9] The process described above is an example of a knowledge and quality of care cycle (Figure 1), in which high-quality clinical research initiates the formulation of a guideline, new knowledge gaps are identified during the guideline development process, and the guideline is revised and implemented. However, the impact of this cycle on healthcare utilisation remains unclear. We believe that now is the right time to re-evaluate the care process to analyse whether results were implemented in clinical practice. Therefore, the aim of this study was to evaluate changes in healthcare utilisation in paediatric tonsil surgery during and after the quality of care cycle in the Netherlands.

Key points

- In the Netherlands, a quality of care cycle was performed on the effectiveness of adenotonsillectomy and adenoidectomy in children with upper respiratory tract infections.
- Between 2005 and 2018, numbers of adenotonsillectomies decreased with 39% and numbers of adenoidectomies decreased with 49%.
- The largest decrease was observed after 2012 and a decrease in number of procedures was seen in all hospital types (i.e. general hospitals, teaching hospitals, university hospitals and private clinics).
- Our analyses revealed only small changes in patient selection, for diagnosis, patient's age, patient's socioeconomic status, and days between date of first consultation and date of surgery.
- The decrease in numbers of procedures was accompanied by an estimated €5.3 million mean savings per year on the healthcare budget and €10.4 million per year on societal costs.

2 | MATERIAL AND METHODS

We performed a retrospective, population-based observational study. This study follows the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendation for observational studies.10 R version 3.6.1 was used for fitting the generalised additive model and for the change point analyses. SPSS Statistics software (version 25; IBM Corp) was used for all other statistical analyses.

2.1 | Data sources

Three data sources were used in this study. First, data per hospital type were collected from the "Diagnosis Treatment Codes" (DBC) Information System (DIS), administered by the Dutch Healthcare Authority. The nationwide collected records collected in this administrative database were previously found to be highly accurate when compared with data from hospital records.[11,12] The completeness of the dataset varied from 83% in 2005 to 100% between 2011 and 2014 as assessed by the Dutch Healthcare Authority. Number of procedures per hospital type between 2005 and 2010 were extrapolated to full national coverage by dividing the number of procedures per year by the percentage of completeness for registered claims in this year.[13] After 2014, the dataset has not yet been completed due to administrative difficulties. To analyse the most recent years, a second dataset covering 2010 to 2018 was retrieved from the LOGEX benchmark register (LOGEX, Amsterdam, the Netherlands). This benchmark register contains data from 37 general hospitals and teaching hospitals (± 46% of all Dutch hospitals). The trend from this benchmark database was used to extrapolate the DIS data from 2015 to 2018. The LOGEX benchmark register features treatment and patient characteristics registered within the hospital information systems. These data are primarily used for structuring and reimbursement of delivered care and have also been proven to be useful for quality assessment studies

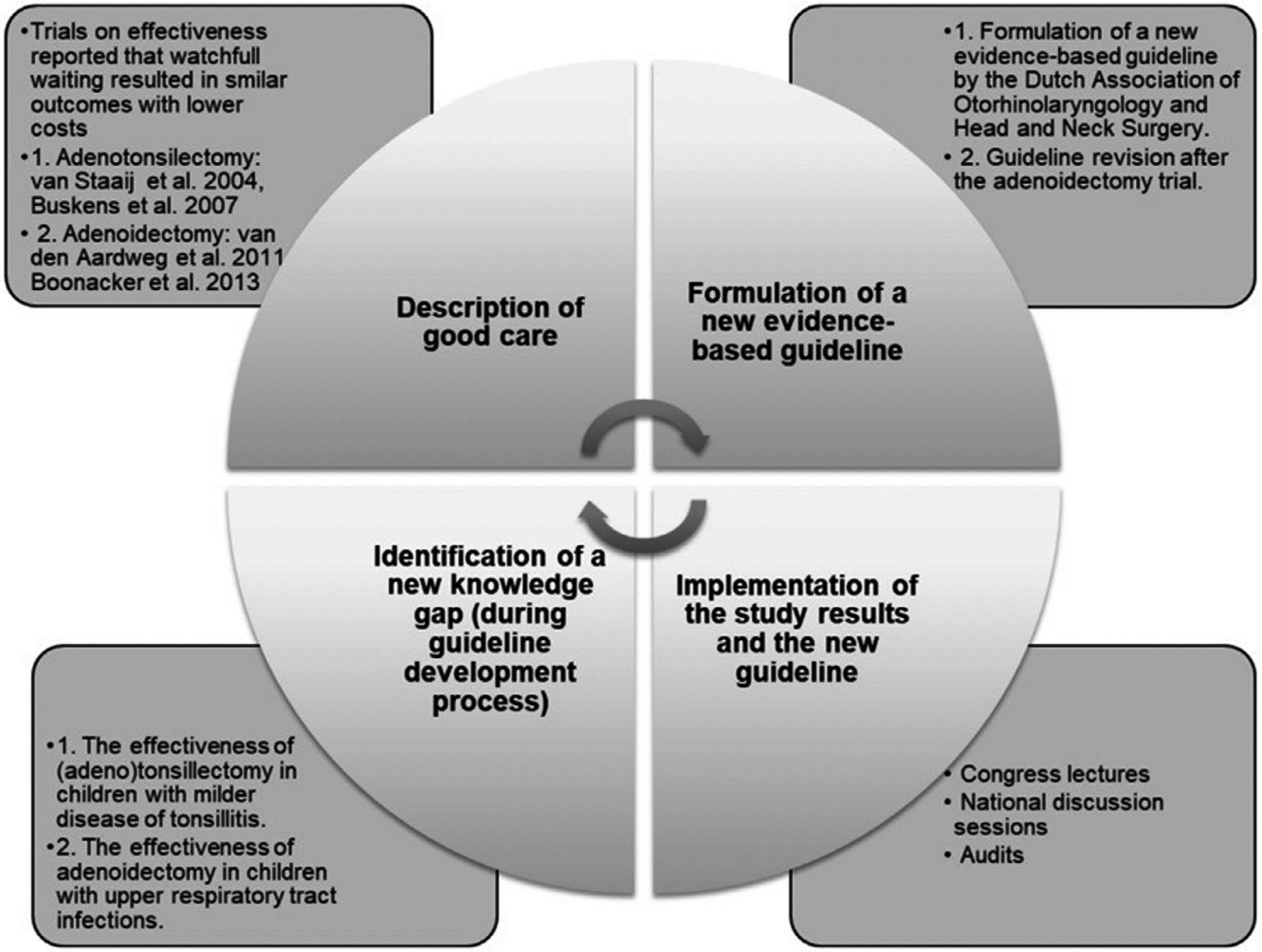

FIGURE 1 The quality of care cycle on the effectiveness of adenotonsillectomy and adenoidectomy in children

in the Netherlands.[11,12] Since almost all paediatric tonsil surgery is performed in general and teaching hospitals in the Netherlands, we assumed that secular trends in this database are representative of nationwide trends. This was confirmed, as trends between 2010 and 2014 were comparable for the two databases (Figure A1). Third, we used the online database from Statistics Netherlands (CBS) to extract data on numbers of inhabitants at risk (up to age 10) in the Netherlands for each year.[14] No ethical approval was required in this study due to patient and hospital anonymity in the administrative database. For the use of the anonymised data, permission was provided by the companies.

2.2 | Variable selection

In the Netherlands, care activities for a patient combine into care products ("DBC-DOT Zorgproducten"), which are similar to diagnosis-related groups (DRGs) and are primarily used for structuring and reimbursement of care delivery to healthcare providers. The number of procedures for both DIS and LOGEX were identified as care products 032 320 (tonsillectomy with or without adenotonsillectomy up to age 10) and code 032 330 (adenoidectomy) in children up to age 10. Since age 0 to 10 years is mentioned in the care activity 032 320, we used the age of 10 years as the upper limit for patient selection. Furthermore, we collected data for the following diagnosis codes: 0302.13 (acute otitis media (OMA), otitis media with effusion (OME), tube dysfunction), 0302.52 (diseases of the tonsils) and 0302.59 (Obstructive Sleep Apnoea). The content of these DBCs were reviewed with members of the national scientific ENT society. We retrieved the following characteristics from the LOGEX registration: patient's age (years), sex (male vs. female), comorbidity (Charlson Comorbidity Index15), patient's socioeconomic status (SES) based on four digit postal code (SES; 1, 2 or 3 (low to high)), diagnosis codes, days between date of first outpatient clinic visit and date of surgery.

2.3 | Data analyses

We analysed surgical rates per 10 000 inhabitants at risk by calculating the number of procedures per 10 000 mid-year population from the online database of the CBS and in-hospital surgical rates per 1 000 clinic visitors by calculating the number of procedures

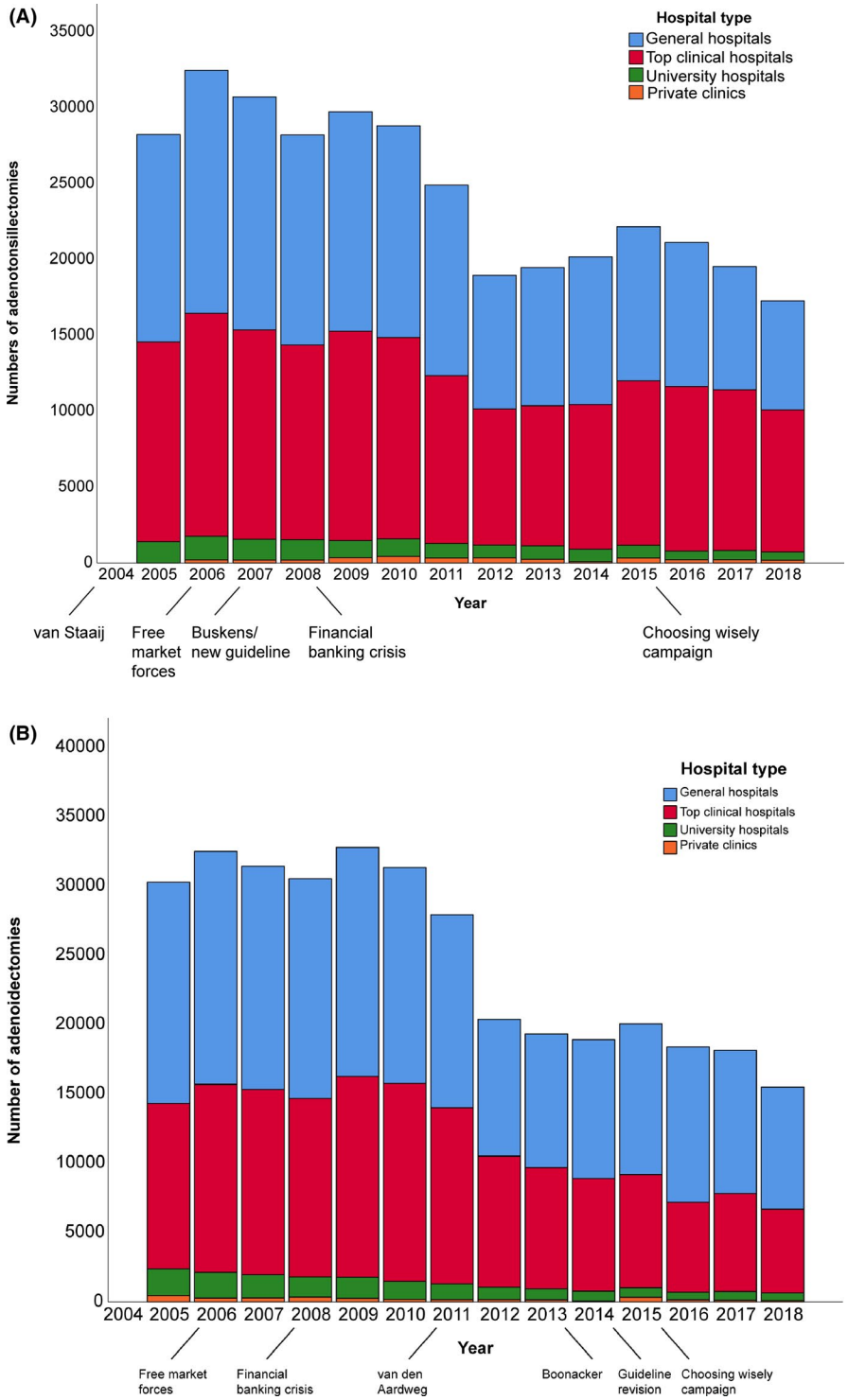

FIGURE 2 A, Absolute number of adenotonsillectomies in children age 0-10 years in the Netherlands between 2005 and 2018. B, Absolute number of adenoidectomies in children age 0-10 years in the Netherlands between 2005 and 2018

per 1 000 children referred to the hospital with the above-mentioned diagnosis treatment codes. The overall trend in compliance was modelled as a smoothed curve using a generalised additive model (gam), which allows for non-linear effects of predictors. A change point analysis was performed using continuous change point locations to analyse the most pivotal change point in surgical rates. Changes in patient selection were expected due to the quality of care cycle, so procedure rates were not adjusted for patient characteristics. Furthermore, surgical patient characteristics before and after the pivotal time point were compared using univariate analyses. We performed Chi-square tests, Fisher Exact tests, independent *t-tests*, *and Mann-Whitney U tests*. Missing data patterns were analysed for all patient characteristics. Subsequently, missing data were replaced using multiple imputation with 10 imputation sets using the variables SES, age and comorbidities as predictors.

2.4 | Cost analyses

We assessed the impact on costs from both a healthcare and societal perspective by comparing mean costs per year before and after the identified pivotal change point. The impact on healthcare budget was measured by calculating the difference in mean number of procedures per year between periods multiplied by the mean price per procedure. The mean price in 2017 based on the 37 LOGEX hospitals (including fee for medical specialists) was €331.27 for an adenotonsillectomy and €180.06 for an adenoidectomy. Subsequently, the impact on societal budget was measured by multiplying the difference in mean number of procedures per year with the cost difference between an operation and watchful waiting. This difference was based on cost-effectiveness studies conducted for the Dutch situation,[3,16] which also accounted for relevant societal costs (e.g. day care, parental leave of absence). We adjusted for inflation using the consumer price index.[3,16,17] Compared to an initial watchful waiting policy, the differences in societal costs for adenotonsillectomy and adenoidectomy were €324 (ie €252 plus 28.5% inflation from 2002 to 2017) and € 608 (ie €541 plus 12.3% inflation from 2009 to 2017), respectively.

3 | RESULTS

3.1 | Outcomes on numbers of tonsillectomies with or without adenoidectomies

First, in patients up to 10 years old, the absolute number of adenotonsillectomies decreased from 28 237 to 17 285 procedures between 2005 and 2018 (−39%, Figure 2A and Table A1 for absolute numbers). The largest decrease was observed in university hospitals (−61%) and the smallest decrease in private clinics (−8%). Second, the annual procedure rate of adenotonsillectomies decreased from 129 per 10 000 children to 87 per 10 000 children. Third, in-hospital surgical rates of adenotonsillectomies decreased from 149 to 116 procedures (−28%) per 1000 clinic visitors aged 0 to 10 years (Figure 3). The year 2012 was identified as a pivotal change point (Figure 4A).

3.2 | Outcomes on numbers of adenoidectomies

The absolute number of adenoidectomies per year decreased from 30 257 to 15 500 (−49%, Figure 2B and Table A2). The decrease was seen for all hospital types, ranging between a decrease of 45% in general hospitals and a decrease of 76% in private clinics. Furthermore, the annual incidence rate of adenoidectomies decreased from 138 to 78 procedures per 10 000 children. Additionally, in-hospital surgical rates decreased from 160 to 104 (−35%) procedures per 1000 clinic visitors per year, respectively. Similar to adenotonsillectomies, the year 2012 was identified as a pivotal change point (Figure 4B).

3.3 | Missing values

Of a total of 98 667 patients who underwent an adenotonsillectomy between 2010 and 2018, data on SES were missing for 4124 patients (4%) in the LOGEX benchmark register. For 2202 patients (2%), data were missing on the number of days between first visit and surgery. Of a total of 90 791 patients who underwent adenoidectomy, 4356 patients (3%) missed values on SES, and 2024 patients (2%) missed values on the number of days between first visit and surgery.

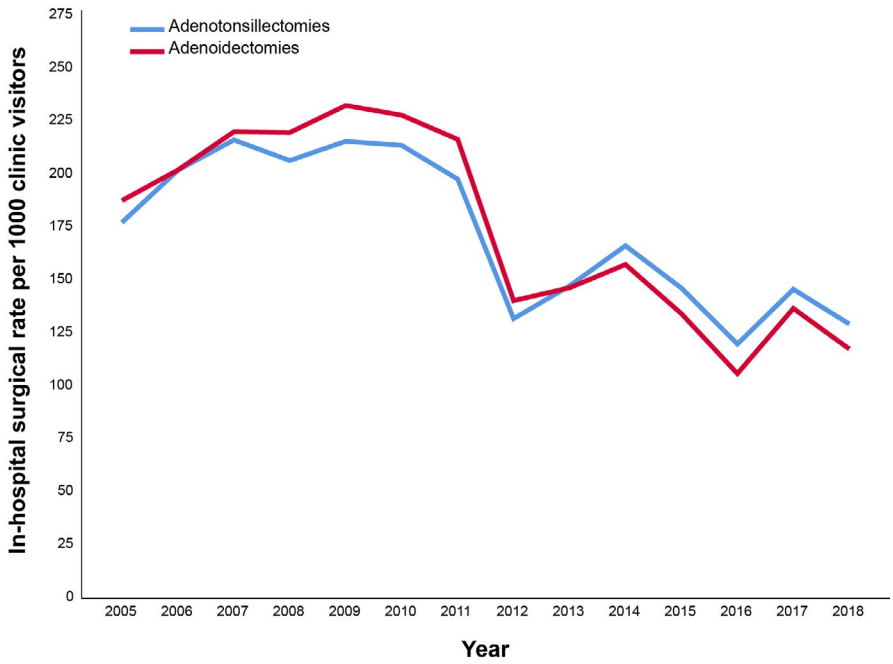

FIGURE 3 In-hospital surgical rates for adenotonsillectomies and adenoidectomies in children age 0-10 years in the Netherlands between 2005 and 2018.

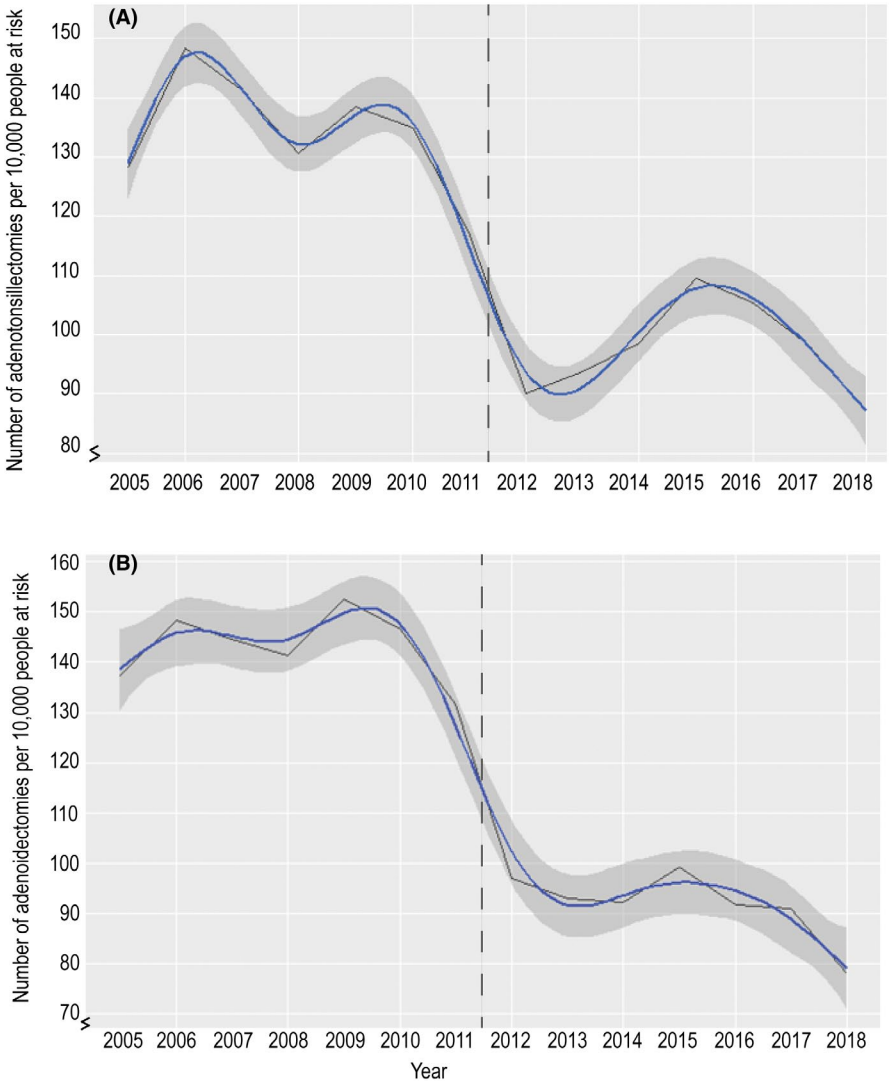

FIGURE 4 A, Number of adenotonsillectomies per 10 000 children age 0-10 years in the Netherlands between 2005 and 2018. B, Number of adenoidectomies per 10 000 children age 0-10 years in the Netherlands between 2005 and 2018

3.4 | Patient selection differences between the periods before and after the pivotal change point

Table 1 presents the patient selection for children who underwent adenotonsillectomy or adenoidectomy and differences between the time periods. Comparing both time periods, we observed significant, but small differences in characteristics for both adenotonsillectomy patients and adenoidectomy patients.

3.5 | Cost analyses

The annual number of adenotonsillectomies decreased from 29 014 over the period 2005-2011 to 19 820 over the period 2012-2018. Annual healthcare costs decreased accordingly, from 9.6 million euro to 6.6 million euro (-31%). Moreover, annual societal costs decreased from 9.4 million euro to 6.4 million euro (-32%). The annual number of adenoidectomies decreased from 30 957 (2005-2011) to 18 670 (2012-2018). Annual healthcare costs decreased accordingly, from 5.6 million euro to 3.4 million euro (-39%), and societal costs decreased from 18.8 million euro to 11.4 million euro (-39%). Based on these numbers, annual healthcare cost reductions for adenotonsillectomies and adenoidectomies in children age 0 to 10 years was 5.3 million euro per year in the 2012-2018 period compared to the period 2005-2011, and the reduction of societal costs was 10.4 million euro per year.

4 | DISCUSSION

Numbers of adenotonsillectomies and adenoidectomies in children aged 0 to 10 years decreased substantially in the Netherlands with subsequently lower healthcare and societal costs. Our study revealed only small changes in patient selection. The year 2012 was identified as a pivotal change point for adenotonsillectomies as well as for adenoidectomies. For adenoidectomies, this occurred in directly after publication of the study results on the effectiveness of this procedure.[8] Implementation of trial results could potentially be enhanced by improved participation of healthcare providers, patients and prompt revision of guidelines. In the Netherlands, a modular structure for guidelines was

TABLE 1 Patient selection for tonsil surgery before and after 2012 (LOGEX, n = 37 hospitals)

	(Adeno)tonsillectomy (age 0-10 years)			Adenoidectomy (age 0-10 years)		
Variables	**2010-2011 (n = 26 842)**	**2012-2018 (n = 71 825)**	***P*-value**	**2010-2011 (n = 26 877)**	**2012-2018 (n = 63 914)**	***P*-value**
Diagnosis (n, %)						
Diseases of the tonsils	25 812 (96)	66 444 (93)	<.001[b,*]	16 890 (63)	36 479 (57)	<.001[b,*]
OME[a] or tube dysfunction	895 (3)	2965(4)		9478 (35)	25 780 (40)	
Obstructive sleep apnoea	3 (0)	1214 (2)		0 (0)	77 (0)	
Other	132 (1)	1211 (2)		509 (2)	1578 (3)	
First visit until surgery (days (median, IQR)	26 (15-42)	29 (17-50)	<.001[*]	26 (14-42)	29 (16-54)	<.001[*]
Sex, female (n, %)	11 992 (45)	32 414 (45)	.21	11 236 (42)	26 426 (41)	.20
Age, years (mean, SD)	4.3 (2.0)	4.5 (1.9)	<.001[*]	3.3 (2.2)	3.7 (2.2)	<.001[*]
Charlson Comorbidity Index (n, %)						
0	25 992 (97)	69 462 (97)	.2	25 591 (95)	60 829 (95)	.19
1	740 (3)	2006 (3)		1103 (4)	506 (4)	
>2	110 (0)	357 (1)		183 (1)	506 (1)	
SES[c] (n, %)						
Low	9472 (35)	23 694 (33)	<.001[*]	10 070 (37)	21 098 (33)	<.001[*]
Middle	8976 (33)	24 493 (34)		9257 (34)	22 569 (35)	
High	8394 (31)	23 638 (33)		7550 (28)	20 247 (32)	

[a]Otitis media with effusion.

[b]Fisher exact test.

[c]Socioeconomic status.

*Statistical significant.

introduced by the Dutch Federation of Medical Specialists, which enables prompt changes of certain sections of guidelines without a time-consuming revision of the entire guideline. Though, the year 2012 was years after the publication of the first study on the effectiveness of adenotonsillectomy (2004) and the introduction of the accompanying guideline (2007),[6,18] despite the fact that a lot of effort was spent on implementing the guideline by means of lectures, publications and audits. Therefore, other reasons for a decrease in procedures were considered as well. For example, the global financial crisis and changes in the registration of electronic health records in the Netherlands around 2012 might have led to a reduction in number of procedures. However, the significant decrease in 2012 was not observed for other surgical procedures.[19-21] Thereby, it remains unclear why such a pivotal decrease in number of adenotonsillectomies was observed in 2012.

One could argue that the decrease in procedures can lead to under-treatment as well, especially since a more recent randomised controlled trial showed that children with sleep disordered breathing can benefit from adenotonsillectomies.[22] However, adenotonsillectomy patients were relatively more often diagnosed with obstructive sleep apnoea in our data. Additionally, the surgical rate in the Netherlands was found high compared to other countries in 1998, suggesting over treatment in earlier years.[1] Nowadays, the incidence in the Netherlands is more similar to the incidence in other countries, like Germany and Sweden.[23-25] For future research, it would be interesting to make a more elaborate comparison between procedure rates in different countries and indications for surgery. Also, it would be interesting to evaluate regional variation in surgical rates within countries, since it is thought that stricter indications for surgery reduce variation in clinical practice.[26]

One might reflect that a decrease in procedures in younger children will be accompanied by an increase in procedures in older children. Therefore, we calculated the yearly incidence rate for both adenotonsillectomy and adenoidectomy in children aged 11 to 15 years between 2010 and 2018 (LOGEX dataset). A decrease was observed for both procedures in older children as well: adenotonsillectomies decreased from 18 to 12 per 10 000 children at risk, and adenoidectomies from 9 to 6 per 10 000 children at risk (Figure A2).

Our results also emphasise that the scientific studies involved had a big return on investment in terms of lower healthcare and societal costs. The costs incurred for conducting the scientific studies (two grants from the Netherlands Organisation for Health Research and Development) and guideline development (financed by the Quality Funds Foundation of Medical Specialists) were estimated to be around € 1.0 million. With this one-time investment, structural annual savings were approximately €5.3 million for the healthcare budget and of about €10.4 million in terms of societal costs. The "strategic exploration of shared savings" report from the Dutch Organisation

for Health Research and Development (ZonMw) outlines a number of scenarios according to which part of these savings could be used for new research, so called "shared savings".[27] Hereby, the "improved quality of healthcare at lower costs" cycle will keep on spinning.

4.1 | Strengths and limitations

To the best of our knowledge, this is the first study that investigated the impact of a quality of care cycle on healthcare utilisation in the Netherlands. A strength of this study is the long time frame of 14 years which allowed to differentiate between a transient and permanent reduction in procedure rates and costs over time. However, data from before the first trial were not available, hindering to prove a causal relationship between the publication of the clinical trial and changes in healthcare practice. Furthermore, the calculations for the consequences of the quality of care cycle on the healthcare budget were based on the mean price of the procedures in 37 general and teaching hospitals. We believe that this price is representative for all Dutch hospitals, except for university hospitals, where the cost price will be higher.[28] Therefore, our calculation of the effects on the healthcare budget is likely to be an underestimation.

5 | CONCLUSION

The analyses of this study showed that during the quality of care cycle for paediatric adenotonsillectomy and adenoidectomy, the numbers of procedures decreased in the Netherlands along with a concomitant reduction of the healthcare and related societal costs. We advise to invest a part of these savings in new research. In this way, the cycle will keep on spinning, which will allow for further refinement of indications and will possibly lead to a further decrease in number of procedures.

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CONFLICT OF INTEREST

All authors declare no competing interests.

AUTHOR CONTRIBUTIONS

JM, PB, WP, WH and AZN conceptualised and designed the study. JM, TB and JH performed the the Dutch Healthcare Authority data analyses. JM, RB and JV performed the LOGEX data analyses. JM, WH, TB and JH performed the cost analyses. JM, SB and WH performed the change point analyses. JM, AZN, JH and TB drafted the manuscript. All authors contributed to acquisition, analysis and interpretation of data, critically revised the manuscript for important intellectual content, and performed study supervision. PB is the guarantor of the study.

DATA AVAILABILITY STATEMENT

Restrictions apply to the availability of these data, which were used under licence for this study. Data are only available with the permission of LOGEX and the Dutch Healthcare Authority.

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APPENDIX A

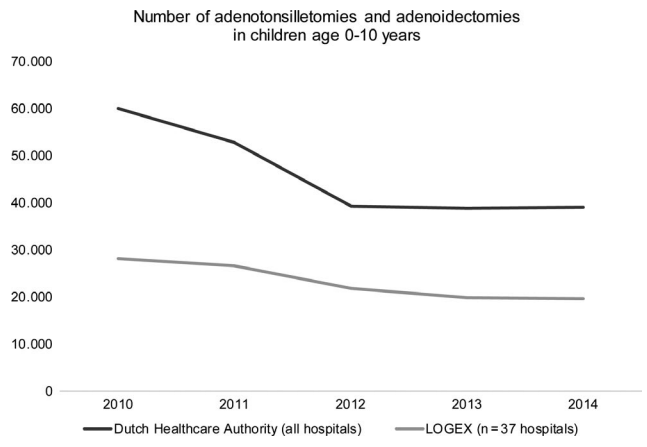

FIGURE A1 Comparison between the Dutch Healthcare Authority database and the LOGEX database on numbers of adenotonsillectomies and adenoidectomies

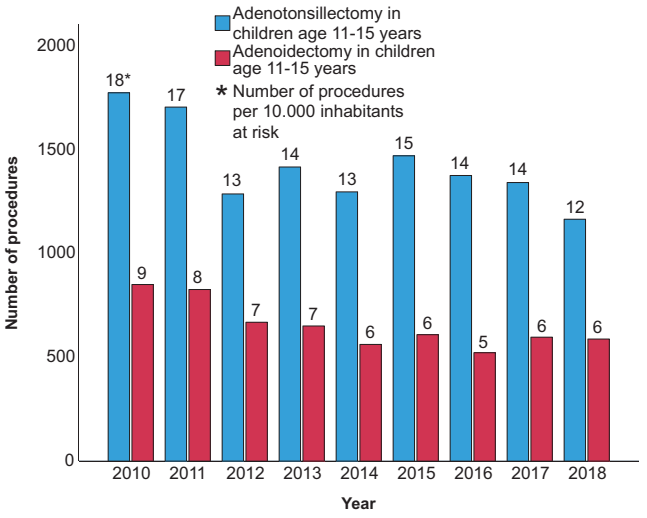

FIGURE A2 Adenotonsillectomy and adenoidectomy in children aged 11-15 years

TABLE A1 Adenotonsillectomies in children up to age 10 2005-2018 (DIS and Logex)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number	28 237	32 474	30 718	28 205	29 739	28 821	24 905	18 964	19 476	20 183	22 166	21 119	19 544	17 285
Year to year	-	+15%	-5%	-8%	+5%	-3%	-14%	-24%	+3%	+4%	+10%	-5%	-7%	-12%
Versus 2005	-	+15%	+9%	0%	+5%	+2%	-12%	-33%	-31%	-29%	-22%	-25%	-31%	-39%
/1000 children	12.9	14.9	14.2	13.1	13.9	13.6	11.8	9.1	9.5	10.0	11.1	10.6	9.8	8.7
/1000 visitors	149	168	177	169	174	174	162	130	129	144	129	109	129	116
General hospitals	13 659	16 017	15 355	13 837	14 462	13 946	12 548	8804	9106	9745	10 155	9487	8115	7177
Teaching hospitals	13 175	14 684	13 794	12 822	13 795	13 281	11 069	8982	9239	9518	10 842	10 833	10 599	9374
University hospitals	1403	1569	1368	1352	1128	1149	953	831	882	834	830	586	618	547
Private hospitals	0	204	201	194	354	445	335	347	249	86	339	213	213	188
2004: van Staaij / presented at the NVKNO congress		Free market forces	Buskens / guideline revision and presentation	Financial crisis			van den Aardweg		Boonacker	Guideline revision and presentation at the NVKNO congress		Choosing wisely campaign		

TABLE A2 Adenoidectomies 2005-2018 (DIS and Logex)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number	30 257	32 491	31 422	30 520	32 773	31 312	27 923	20 385	19 332	18 907	20 053	18 371	18 145	15 500
Year to year	-	+7%	-3%	-3%	+7%	-4%	-11%	-27%	-5%	-2%	+6%	-8%	-1%	-15%
Versus 2005	-	+7%	+4%	+1%	+8%	+3%	-8%	-33%	-36%	-38%	-34%	-39%	-40%	-49%
/1000 children	13.8	15.0	14.6	14.2	15.3	14.8	13.3	9.8	9.4	9.3	10.0	9.2	9.1	7.8
/1000 visitors	160	168	181	183	192	189	182	124	128	135	117	95	119	104
General hospitals	15 934	16 809	16 108	15 861	16 506	15 566	13 919	9872	9653	10 003	10 862	11 193	10 317	8813
Teaching hospitals	11 944	13 556	13 366	12 863	14 490	14 254	12 701	9454	8734	8134	8166	6480	7087	6054
University hospitals	1938	1844	1655	1456	1527	1304	1130	883	785	696	693	535	618	528
Private hospitals	441	282	293	340	250	188	173	176	160	74	332	163	123	105
2004: van Staaij/ presented at the NVKNO congress		Free market forces	Buskens / guideline revision	Financial crisis			van den Aardweg	Presented at the NVKNO congress	Boonacker	Guideline revision and presentation at the NVKNO congress		Choosing wisely campaign		