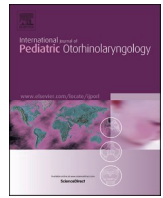


Contents lists available at [ScienceDirect](https://www.sciencedirect.com)

International Journal of Pediatric Otorhinolaryngology

journal homepage: www.elsevier.com/locate/ijporl

Postoperative morbidity and mortality after adenoidectomy: A national population-based study of 51 746 surgeries

Hanna Gerhardsson^{a,*}, Joacim Stalfors^b, Ola Sunnergren^a

^a Department of Otorhinolaryngology, Region Jönköping County, and Department of Biomedical and Clinical Sciences, Linköping University, Linköping, Sweden

^b Institute of Clinical Sciences, Sahlgrenska Academy at the University of Gothenburg, Göteborg, Sweden

ARTICLE INFO

Keywords:

Adenoidectomy
Complication
Hemorrhage
Morbidity
Mortality

ABSTRACT

Objectives: To investigate postoperative morbidity and mortality after paediatric adenoidectomy.

Methods: This was a retrospective national population-based cohort study of data from the Swedish National Patient Register (NPR) and The Swedish Cause of Death Register (CDR).

All patients aged 0–18 years who underwent adenoidectomy from 2007 to 2017 (without concomitant tonsil surgery) were included in this study. To evaluate postoperative morbidity and mortality, all diagnostic and surgical codes registered in the NPR for health care contacts within 30 days of surgery were analysed. The patients retrieved from the NPR were matched with the CDR to identify any deaths occurring within 30 days of the surgery.

Results: A total of 51 746 adenoidectomies were included in this study. No deaths related to adenoidectomy were identified. All types of haemorrhagic complications were rare. Only 0.1% of the surgeries resulted in an outpatient contact due to postoperative haemorrhage and only 0.1% of the adenoidectomies resulted in a readmission due to haemorrhage. The rarest haemorrhagic complication was RTT (return to theatre), with only 4 events (0.01%). Postoperative haemorrhage was most frequent on the first day after surgery. Other complications were rare as well, requiring a total of 922 (2.6%) outpatient visits and 75 (0.2%) readmissions in the adenoidectomy group, with postoperative infection being the most commonly reported.

Conclusions: Overall, adenoidectomy should be considered a safe surgical procedure associated with few postoperative complications. No deaths related to adenoidectomy were found. Severe complications, such as late postoperative haemorrhage after adenoidectomy, were rare, and haemorrhage resulting in RTT was even rarer. The highest rate of postoperative haemorrhage was observed the first day after surgery, and most haemorrhagic complications occurred within a week. Comparisons with studies on tonsil surgery show that adenoidectomy is associated with substantially lower postoperative morbidity.

1. Introduction

Adenoidectomy, the surgical removal of adenoid tissue from the nasopharynx, is one of the most commonly performed surgical procedures in the paediatric population. There are many indications for adenoidectomy, including snoring, recurrent upper airway infections, middle ear ventilation problems and nasal obstruction causing mouth breathing [1–3]. There is no international consensus or evidence-based indications for adenoidectomy, which is reflected in the large variations in adenoidectomy indications and surgical rates that have been reported from different countries [4–9]. Consequently, such variations in

adenoidectomy rates are likely dependent on local traditions and differences in the application of indications rather than differences in actual diseases that warrant an adenoidectomy.

Adenoidectomy can be performed as a solitary procedure, but it is often performed in combination with other ENT surgical procedures, such as tonsil surgery or tympanic membrane tube insertion [7,10]. Several studies have reported a higher adenoidectomy incidence for boys than girls, but the reason for this difference remains unexplained [5,7,8,10]. The adenoid tends to grow during early childhood, but when the child reaches adolescence and is less prone to catch upper airway infections, the size of the adenoid decreases. Adenoid hypertrophy is

* Corresponding author. Department of Otorhinolaryngology, Region Jönköping County, and Department of Biomedical and Clinical Sciences, Linköping University, Linköping, Sweden.

E-mail address: hanna.gerhardsson@rjl.se (H. Gerhardsson).

<https://doi.org/10.1016/j.ijporl.2022.111335>

Received 31 March 2022; Received in revised form 22 June 2022; Accepted 1 October 2022

Available online 4 October 2022

0165-5876/© 2022 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

therefore seldom observed in adolescents and very seldom in adults, and naturally, adenoidectomy is predominantly an operation of childhood.

Even though adenoidectomy is such a common procedure, it has been less studied than many other procedures, such as tonsil surgery. In particular, postoperative morbidity in terms of complications after tonsil surgery has been well studied, while such studies on adenoidectomy are limited. The reason for this may be that adenoidectomy is considered a procedure associated with few severe complications [11], as previous studies have shown that the risk of postoperative haemorrhage is low [7, 12–15]. A limitation is that these studies, with the low complication rates in mind, are likely to be underpowered and have seldom addressed postoperative mortality. The low rates of complications associated with adenoidectomy require very large populations to establish valid rates of rare outcomes, which may be another reason why these studies have been rare.

Adenoidectomy has often been studied together with tonsil surgery, as these two surgeries are often performed simultaneously. A challenge with combined tonsil and adenoid surgery studies is that it is difficult to differentiate between complications related to the adenoidectomy vs. those related to the tonsil surgery. For studies on adenoidectomy, it would be more informative if descriptions and rates of postoperative complications after adenoidectomy were studied alone. Studies reporting, or discussing mortality after a solitary adenoidectomy are even rarer, and most are underpowered due to the low number of included surgeries. Other studies are either case reports, old, focus on anaesthesia related complications, or include concomitant tonsil surgery [16–18].

Studies on specific adenoidectomy morbidity and mortality are thus warranted. The National Patient Register (NPR) in Sweden contains detailed individual data on all ENT care, and The Swedish Cause of Death Register (CDR) registers the cause of death of all Swedish citizens [19,20]. These national databases, which cover inpatient care since the 1960s and outpatient care since 2001 from both private and public caregivers as well as causes of death, are well suited for the study of surgical procedures where complications and deaths are expected to be rare.

The aim of this study was to describe and evaluate the postoperative morbidity and mortality after paediatric adenoidectomy in Sweden by matching data from these two national population-based health care registers.

2. Material and methods

2.1. Study design

This was a retrospective population-based cohort study based on data from the Swedish NPR and CDR. Both the NPR and the CDR are managed by The National Board of Health and Welfare, a government agency under the Ministry of Health and Social Affairs. The NPR contains individual patient data on diagnoses and surgical procedures from both in- and outpatient specialist care. Primary care is not covered in the NPR, but all specialist public and private health care providers in Sweden are legally required to register their medical data in the NPR.

Surgical procedures are registered in the NPR according to The Nordic Medico-Statistical Committee Classification of Surgical Procedures (NOMESCO) [21]. All surgical procedures have a unique code, and all concomitant procedures during one surgical session are mandated to be registered. Indications for surgery and medical visits are registered according to the International Statistical Classification of Diseases (ICD).

For this study, data for all patients aged 0–18 years registered with an adenoidectomy 2007–2017 were retrieved from the NPR. The retrieved data included sex, age at adenoidectomy, date of adenoidectomy, indication for adenoidectomy (ICD-codes), information on concomitant surgeries, and whether adenoidectomy was performed as an out- or inpatient surgery. To evaluate the postoperative morbidity, data for all diagnostic and surgical codes registered for health care contacts within 30 days of surgery were retrieved. This information

included the date and level of care of each event. All patients included in the study sample were matched using Swedish personal identification numbers with the CDR to identify any deaths occurring within 30 days of the surgery (including perioperative death due to anaesthesia but also traffic accidents etc.). Patients with concomitant non-ENT surgery, concomitant tonsil surgery, an indication code indicating that the reason for surgery was a malignant disease, or where follow-up after surgery was less than 30 days were excluded from the study.

In the analysis, the study population was categorized into groups based on the surgical procedures performed. Only adenoidectomy (a solitary adenoidectomy) and adenoidectomy + ear surgery (ear surgery includes all surgery from the external ear to the middle ear) were included in the study. Postoperative morbidity was analysed in terms of in- and outpatient care due to haemorrhage, return to theatre (RTT) due to haemorrhage, and in- and outpatient care due to causes other than haemorrhage. Haemorrhage occurring before discharge from the initial adenoidectomy is not reported to the NPR; therefore, these haemorrhages and other peri-operative complications are not included in this study.

A preliminary analysis of the dataset revealed that more than 1000 combinations of different diagnostic codes were registered for health care contacts within the first 30 days after surgery. A selection of ICD codes that could be relevant in terms of potential morbidity after adenoid surgery was therefore performed. Health care visits where specific non-ENT codes were used (diabetes, eczema, obesity, etc.), codes indicating examination and consulting, and ENT diagnoses not indicating a complication (hypertrophy, snoring, etc.) were thereby excluded when assessing postoperative complications. A full list of the excluded ICD10 codes is presented in the supplementary material (available upon request). If more than one diagnostic code was registered, the main diagnostic code (i.e., the first code in the NPR) was used for categorization. The definitions of postoperative haemorrhage, RTT and other non-haemorrhagic complications are presented in Table 1.

This study was approved by the Regional Ethical Review Board in Linköping, Sweden (2018/390–31).

2.2. Statistical analysis

Categorical variables are presented as numbers and percentages, and continuous variables are presented as the mean (standard deviation) and median (minimum, maximum). For comparisons between groups, Fisher's exact test (lowest one-sided p-value multiplied by 2) was used for dichotomous variables, the Mantel–Haenszel chi-square test was used for ordered categorical variables, and the *t*-test was used for continuous variables.

To identify predictors for postoperative haemorrhagic complications, univariable logistic regression was used. The variables were age, sex, year of surgery and primary adenoidectomy/reoperation adenoidectomy. The results from the logistic regression analyses are given as odds ratios (ORs) with 95% confidence intervals (CIs) and p values. All significance tests were two-sided and conducted at the 5% significance level. SAS software version 9.4 (SAS Institute, Cary, NC) was used for statistical analyses.

3. Results

3.1. Demographics and general characteristics

In total, 51 746 adenoidectomies performed from 2007 to 2017 were included in this study. The demographics and general characteristics of the studied population are presented in Table 2. A total of 35 470 patients (68.5%) underwent adenoidectomy as a solitary procedure, 16 276 patients (31.5%) had simultaneous ear surgery (adenoidectomy + ear surgery). The most common concomitant surgery in the adenoidectomy + ear surgery group was tympanic tube insertion followed by tympanocentesis. Boys constituted approximately 60% of the

Table 1

Definitions of postoperative haemorrhage, return to theatre due to haemorrhage, and nonhaemorrhagic complications based on the International Classification of Diseases (ICD) and The Nordic Medico-Statistical Committee Classification of Surgical Procedures.

Postoperative haemorrhage	Return to theatre due to haemorrhage
T81.0 Haemorrhage and haematoma complicating a procedure, NEC	EMB 30 Adenoidectomy + postoperative haemorrhage ICD code
T81.1 Shock during or resulting from a procedure, NEC	EMW 99 Other operations on tonsil or adenoids + postoperative haemorrhage ICD code
T81.2 Accidental puncture and laceration during a procedure, NEC	EMC00 Suture of tonsil or adenoids + postoperative haemorrhage ICD code
T81.7 Vascular complications following a procedure, NEC	EWD 00 Reoperation for superficial haemorrhage in surgery of teeth, jaws, mouth and pharynx
D 62.9 Acute post haemorrhagic anaemia	EWE 00 Reoperation for deep haemorrhage in surgery of teeth, jaws, mouth and pharynx
R04.1 Haemorrhage from throat	EWV 99 Other reoperations in surgery of teeth, jaws, mouth and pharynx
R04.2 Haemoptysis	DWD 00 Reoperation for superficial haemorrhage in surgery of ear, nose and larynx
R04.8 Haemorrhage from other sites in respiratory passages	DWE 00 Reoperation for deep haemorrhage in surgery of ear, nose and larynx
R04.9 Haemorrhage from respiratory passages, unspecified	DWW 99 Other reoperation in surgery of ear, nose and larynx
R57.1 Hypovolemic shock	
R58.9 Haemorrhage, NEC	
Other complications than haemorrhage	
R11, R13, R50-R69, E86 General symptoms and signs (fever, pain, fatigue, nausea and vomiting, dysphagia, symptoms and signs concerning food and fluid intake, volume depletion)	
R04, T88, T818-T819, R47, R49 Symptoms NEC (epistaxis, other complications of surgical and medical care, speech disturbances, voice and resonance disorders)	
H65-69, H92 Diseases of the ear (otitis media, disorders of the Eustachian tube, otalgia)	
J00-J06, T81.4, A30-49, B25-B34, B95-B99 Infections (acute upper respiratory infections/infection following a procedure (bacterial, viral and other infectious agents/diseases)	

Abbreviations: Not elsewhere classified (NEC).

Table 2

Demographics and general characteristics of the study population.

	Total (n = 51746)	Adenoidectomy (n = 35 470)	Adenoidectomy + ear surgery (n = 16 276)
Gender, n (%)			
Boys	30560 (59.1%)	20742 (58.5%)	9818 (60.3%)
Girls	21186 (40.9%)	14728 (41.5%)	6458 (39.7%)
Age, mean (SD)/median (min; max)	6.36 (3.78)	6.93 (4.03)	5.11 (2.78)
	5.34 (0.02; 19)	5.94 (0.02; 19)	4.51 (0.61; 18.93)
Level of care, n (%)			
Outpatient	49809 (96.3%)	34123 (96.2%)	15686 (96.4%)
Inpatient	1937 (3.7%)	1347 (3.8%)	590 (3.6%)
Primary adenoidectomy/reoperation, n (%)			
primary	45498 (87.9%)	31213 (88.0%)	14285 (87.8%)
reoperation	6248 (12.1%)	4257 (12.0%)	1991 (12.2%)
Year of surgery, n (%)			
2007	4394 (8.5%)	2931 (8.3%)	1463 (9.0%)
2008	4504 (8.7%)	3038 (8.6%)	1466 (9.0%)
2009	4492 (8.7%)	2949 (8.3%)	1543 (9.5%)
2010	4758 (9.2%)	3218 (9.1%)	1540 (9.5%)
2011	4790 (9.3%)	3157 (8.9%)	1633 (10.0%)
2012	5329 (10.3%)	3525 (9.9%)	1804 (11.1%)
2013	4724 (9.1%)	3314 (9.3%)	1410 (8.7%)
2014	5043 (9.7%)	3517 (9.9%)	1526 (9.4%)
2015	4918 (9.5%)	3424 (9.7%)	1494 (9.2%)
2016	4447 (8.6%)	3215 (9.1%)	1232 (7.6%)
2017	4347 (8.4%)	3182 (9.0%)	1165 (7.2%)
Concomitant surgeries, n (%)			
		Not applicable	Tympanic tube insertion 10 569 (64.9%)
		Not applicable	Tympanocentesis 2674 (16.4%)
		Not applicable	Other ear surgery 3033 (18.6%)
Indications for surgery, n (%)			
		Hypertrophy of the adenoids 31 437 (88.6%)	Hypertrophy of the adenoids + otitis media. 12 108 (74.4%)
		Hypertrophy of the adenoids + snoring 1053 (3.0%)	Hypertrophy of the adenoids 1957 (12.0%)
		Snoring 708 (2.0%)	Hypertrophy of the adenoids + other indications 949 (5.8%)
		Other indications 2272 (6.4%)	Other indications 1262 (7.8%)

Table 3

Outpatient visits, readmissions and return to theatre due to haemorrhage, and outpatient visits and readmissions due to reasons other than haemorrhage presented by the surgical group.

	Total (n = 51746)	Adenoidectomy (n = 35 470)	Adenoidectomy + ear surgery (n = 16 276)	p value
Outpatient visits due to postoperative haemorrhage, n (%)	49 (0.1%)	25 (0.1%)	24 (0.1%)	0.016
Days to contact, mean (SD)/median (min; max)	4.31 (6.01) 2 (1; 29)	3.28 (5.66) 2 (1; 29)	5.38 (6.30) 2 (1; 21)	
Readmissions due to postoperative haemorrhage, n (%)	52 (0.1%)	37 (0.1%)	15 (0.1%)	0.81
Days to readmission, mean (SD)/median (min; max)	3.35 (2.96) 2 (1; 15)	3.41 (2.90) 3 (1; 15)	3.20 (3.21) 2 (1; 12)	
Return to theatre due to haemorrhage, n (%)	4 (0.0%)	3 (0.0%)	1 (0.0%)	1.00
Days to return to theatre, mean (SD)/median (min; max)	1.25 (0.50) 1 (1; 2)	1.33 (0.58) 1 (1; 2)	1.000	
Outpatient visits, other reasons than haemorrhage, n (%)	6683 (12.9%)	3920 (11.1%)	2763 (16.9%)	<.0001
Days to contact, mean (SD)/median (min; max)	13.2 (8.9) 12 (1; 29)	12.9 (8.8) 12 (1; 29)	13.7 (9.1) 13 (1; 29)	
Readmissions, other reasons than haemorrhage, n (%)	281 (0.5%)	185 (0.5%)	96 (0.6%)	0.36
Days to readmission, mean (SD)/median (min; max)	12.6 (9.7) 11 (1; 29)	11.8 (9.7) 10 (1; 29)	14.2 (9.6) 14 (1; 28)	

population. The mean age for the total study cohort was 6.4 years. The adenoidectomy + ear surgery group had a lower mean age (5.1 years) compared with the adenoidectomy group (6.9 years).

The most frequently registered indications for surgery in the adenoidectomy group were hypertrophy of the adenoids, n = 31 437 (88.6%), followed by hypertrophy of the adenoids + snoring, n = 1053 (3.0%), and snoring, n = 708 (2.0%). In the adenoidectomy + ear surgery group, hypertrophy of the adenoids + otitis media n = 12 108 (74.4%) was the most common indication.

An overwhelming majority of the surgeries were outpatient procedures (96%), and 88% of the patients were undergoing their first adenoid surgery. The number of surgeries that were performed annually from 2007 to 2017 varied from 4347 (8.4%) to 5329 (10.3%).

3.2. Postoperative morbidity and mortality

No deaths related to adenoidectomy or the anaesthesia were identified by the matching of the NPR with the CDR datasets. The numbers, rates of in- and outpatients contacts, and RTTs due to complications after adenoidectomy, together with days from surgery to the event, are presented in Table 3.

All types of haemorrhagic complications were rare. Only 0.1% of the surgeries resulted in an outpatient contact due to postoperative haemorrhage and only 0.1% of the adenoidectomies resulted in a readmission due to haemorrhage. The rarest haemorrhagic complication was RTT, with only 4 events. Three of these occurred in the adenoidectomy group.

Most haemorrhagic complications occurred within 6 days of surgery, with a mean of 3.4 days for readmissions and 4.3 days for outpatient visits for the whole population. In the adenoidectomy group, the means were 3.4 days for readmission and 3.3 days for outpatient visits due to postoperative haemorrhage. Notably, no RTT occurred later than 2 days after surgery. Readmissions due to haemorrhage occurred up to 15 days after surgery, while outpatient contacts due to haemorrhage occurred up to the 29th day after surgery. As presented in Fig. 1, the rates of contacts

and readmissions in the adenoidectomy group were most frequent the first day after surgery. Very few haemorrhagic events occurred later than a week after surgery.

Predictors for haemorrhagic complications after adenoidectomy, when performed as a sole procedure, are presented in Table 4. A contradictory finding between outpatient visits and readmissions due to postoperative haemorrhage was observed for gender, where more girls were readmitted but had fewer outpatient visits compared to boys. A higher age at surgery was significantly associated with a higher odds ratio (OR) for both readmission and outpatient visits. No differences in OR were observed between primary adenoidectomies or reoperation of the adenoids. A later year for surgery during the study period was associated with a higher OR for outpatient visits but not for readmissions.

Outpatient visits for (any) reasons other than haemorrhage were more common (Table 3), with significantly higher rates in the group with additional surgery than in the adenoidectomy group. In the adenoidectomy group, the rates were 11.1% compared with rates of 16.9% in adenoidectomy + ear surgery group. Readmissions due to reasons other than haemorrhage were uncommon, with rates of 0.5% in the adenoidectomy group and 0.6% in the adenoidectomy + ear group. The number of days from surgery to event ranged from 1 to 29 days for both outpatient visits and readmissions.

Complications other than haemorrhage were rare, with a total of 922 (2.6%) outpatient visits and 75 (0.2%) readmissions (Table 5) in the adenoidectomy group. The most frequently registered complications were outpatient visits due to acute upper airway respiratory infections. Complications that based on the ICD coding could be directly attributed to adenoidectomy were postoperative infections, with 109 (0.3%) outpatient visits and 11 (0.03%) readmissions; and unspecified complications, with 18 (0.05%) outpatient visits and 6 (0.02%) readmissions.

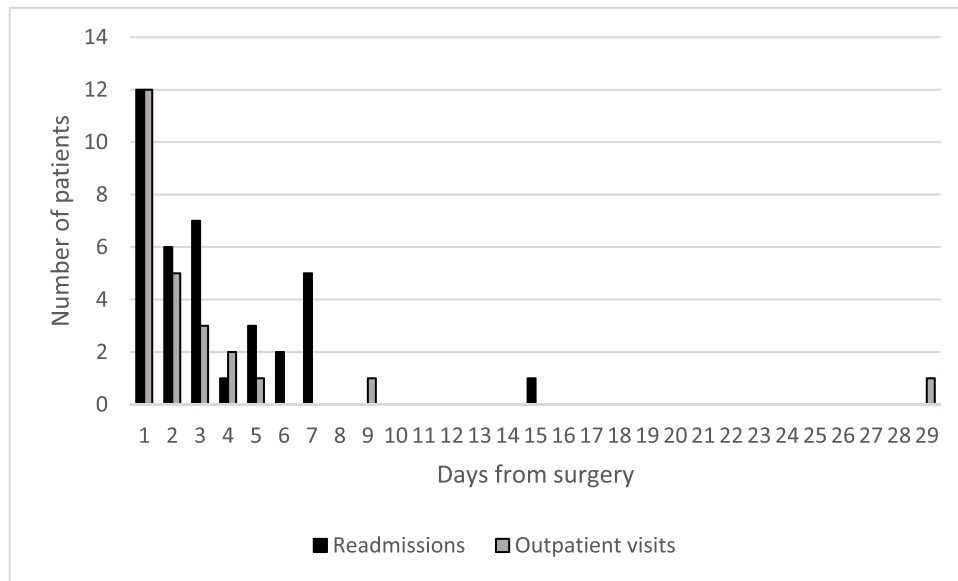


Fig. 1. Days to postoperative outpatient visits and readmissions due to haemorrhage in the adenoidectomy group.

Table 4

Predictors for outpatient visits and readmissions due to postoperative haemorrhage in the adenoidectomy group (n = 35 470) by univariate logistic regression.

Outpatient visits	n (%) of event	OR (95%CI)	p value
Gender			
Boys	17 (0.1%)		
Girls	8 (0.1%)	0.66 (0.29–1.54)	0.34
Age at surgery			
<5	7 (0.0%)		
5-<8	6 (0.1%)		
8-<13	6 (0.1%)		
13–19	6 (0.2%)	1.13 (1.04–1.22)	0.0055
Year of surgery		1.22 (1.06–1.41)	0.0062
Primary adenoidectomy/reoperation			
Primary	22 (0.1%)		
Reoperation	3 (0.1%)	1 (0.30–3.34)	1
Readmissions			
n (%) of event	OR (95%CI)	p value	
Gender			
Boys	15 (0.1%)		
Girls	22 (0.1%)	2.07 (1.07–3.99)	0.030
Age at surgery			
<5	15 (0.1%)		
5-<8	5 (0.1%)		
8-<13	8 (0.1%)		
13–19	9 (0.3%)	1.09 (1.02–1.17)	0.012
Year of surgery		0.96 (0.87–1.07)	0.45
Primary adenoidectomy/reoperation			
Primary	35 (0.1%)		
Reoperation	2 (0.0%)	0.42 (0.10–1.74)	0.23

Abbreviations: OR = Odds Ratio, CI = Confidence interval.

4. Discussion

An important finding was that no deaths related to adenoidectomy were identified among 51 746 surgeries covering a decade. In a Swedish study (Østvoll et al.) of >82 000 tonsil and adenotonsillar surgeries (but not sole adenoidectomies), based on the same database and the same methodology as in this study, only two fatal cases were identified, giving a mortality rate of 0.002% [22]. Both fatal cases occurred after combined adenoid and tonsil surgery, and in both cases, the cause of death was determined by autopsy to be related to bleeding from the tonsil bed.

Table 5

Outpatient and inpatient complications after adenoidectomy (postoperative haemorrhage excluded). Percentages are calculated from the total number of surgeries in the adenoidectomy group (n = 35 470).

Groups based on ICD clusters	ICD codes	Outpatient visits, n (%)	Readmissions, n (%)
Infections			
Acute upper respiratory infections	J00-J06	286 (0.81%)	20 (0.06%)
Infection following a procedure	T814	109 (0.31%)	11 (0.03%)
Bacterial, viral and other infectious agents/diseases	A30–49, B25–B34, B95–B99	73 (0.21%)	3 (0.01%)
Diseases of the ear			
Otitis media	H65–H67	161 (0.45%)	3 (0.01%)
Disorders of the Eustachian tube	H68, H69	11 (0.03%)	0
Otalgia and effusion of ear	H92	8 (0.02%)	0
General symptoms and signs			
Fever, pain, fatigue etc.	R50-R62, R64-R69	174 (0.49%)	15 (0.04%)
Nausea and vomiting, dysphagia	R11, R13	14 (0.04%)	6 (0.02%)
Symptoms and signs concerning food and fluid intake, volume depletion	R63, E86	3 (0.01%)	8 (0.02%)
Symptoms not elsewhere classified			
Epistaxis	R040	60 (0.17%)	3 (0.01%)
Other complications of surgical and medical care, not elsewhere classified	T88, T818-T819	18 (0.05%)	6 (0.02%)
Speech disturbances, voice and resonance disorders	R47, R49	5 (0.01%)	0
Total		922 (2.60%)	75 (0.21%)

Combined with our data, this means that even if death can occur after adenoidectomy, it must be considered extremely rare.

Our study further shows that severe complications after adenoidectomy, such as postoperative haemorrhage resulting in readmission after

discharge from hospital, are rare (0.1%), and haemorrhage resulting in RTT is extremely rare (0.01%). Earlier studies have reported late postoperative haemorrhage rates of 0.0–0.8% [7,13–15], although differences between studies regarding the timeframe and definitions of haemorrhage must be taken into consideration when comparisons are made. In 2012, Tomkinson et al. published a study on postoperative bleeding after adenoidectomy that included 1363 adenoidectomies and 4225 adenotonsillectomies. In this study, 0.39% of the patients had a haemorrhage (occurring within 24 h from surgery) from the adenoid bed resulting in RTT. One patient (0.02%) had a haemorrhage that was managed conservatively. After 24 h, no postoperative haemorrhages requiring an RTT were reported, and only 4 patients (0.07%) were readmitted for conservative treatment. These results are in accordance with the current study, where 0.1% of patients were readmitted to the hospital due to postoperative haemorrhage and 4 cases (0.01%) resulted in an RTT.

In another study on 1939 adenoidectomies with several months of follow-up, Thomas et al. found 26 (1%) cases of haemorrhages, but all occurred in the perioperative phase. In an Australian study by Sarny et al., 0.8% of 3492 adenoidectomies resulted in postoperative haemorrhage and 0.3% in a RTT. In this study, haemorrhage was defined as any bleeding episode after extubation. It is difficult to compare these results with the present study because haemorrhages occurring during hospital stay and before discharge are not reported to the NPR and thus were not considered in the current study. Lowe et al. presented early (during initial stay/delayed discharge) and late postoperative haemorrhage rates (requiring readmission after discharge) between 0.07–0.3% and 0.07%–0.2%, respectively, depending on the surgical technique used (suction diathermy and the traditional cold steel curette technique). In 2019, we performed a national audit (unpublished) on adenoidectomy techniques used in Sweden. The cold steel curette technique was the most frequently used surgical technique, although different electro-surgical techniques were also reported (suction diathermy, coblation, microdebrider, etc.). Unfortunately, the NPR does not contain data on surgical technique; therefore, comparisons with the study by Lowe et al. cannot be made.

Even if the above mentioned studies could be considered underpowered due to the low number of included surgeries in relation to the low complication rates after adenoidectomy, our multicentre study based on a total national population confirms the results of these studies that haemorrhagic complications after adenoidectomy are very rare occurrences.

Most of the haemorrhagic complications (outpatient visits, admissions, RTT) occurred early, within a few days of surgery. The rates of contacts and readmissions in the adenoidectomy group were most frequent the first day after surgery, and no RTT occurred later than 2 days after surgery. In a previous report on haemorrhages after tonsil surgery using the same methodology and database as in this study, Østvoll et al. observed a different time distribution regarding the day when readmission due to postoperative tonsil haemorrhage occurred. In this study, the highest frequency was observed on the sixth day after surgery, and the data appeared to be normally distributed [23]. In our study, the highest rate of readmissions due to haemorrhage occurred on the first day after surgery, followed by a decline (Fig. 1). Even though adults were included in the study by Østvoll et al. the similarities in design, methodology, database and large study sizes between our study and the Østvoll study point out an important difference in the risk for timing of haemorrhage between adenoidectomy and tonsillectomy.

Interesting comparisons with another Swedish study on morbidity after paediatric tonsil surgery (performed with or without simultaneous adenoidectomy) can also be made [24]. This study, by Odhagen et al. had a similar design and database as our study. The rates of readmissions due to haemorrhage were 2.5% after tonsillectomy and 0.6% after tonsillectomy, and the rates of RTT were 0.5% and 0.1%, respectively. A comparison with our rates of 0.1% readmissions and 0.01% RTTs due to haemorrhage indicates that adenoidectomy is associated with

substantially lower rates of postoperative haemorrhagic complications than after tonsil surgeries.

There is no established explanation for the differences between adenoid and tonsil surgery regarding haemorrhage rates and the post-surgical day when haemorrhage most commonly occurs. One hypothesis is that the protected site of the adenoids in the nasopharynx entails a “protected” healing contrary to the tonsil beds, which are exposed to movement during speech and swallowing. Another possibility is differences in vascular supply. The arterial supply to the tonsils stems from several tonsil branches, including the facial artery (the main supply), the ascending palatine artery, the ascending pharyngeal artery, the dorsal lingual artery and the lesser palatine artery. The blood supply to the adenoid comes from the basisphenoid artery, the ascending palatine artery, the ascending pharyngeal artery, the tonsillar branch of the facial artery, the artery of the pterygoid canal and the pharyngeal branch of the maxillary artery. A hypothesis is that the vascular supply to the tonsils consists of larger arteries compared to the adenoids, which, if true, may increase the risk of perioperative damage that increases the risk of haemorrhage during the healing process. Injury to an aberrant course of the internal carotid artery (ICA) has in different case reports been suggested as a possible cause of fatal haemorrhage after adenoidectomy [16,25].

The most frequent nonhaemorrhagic complications that resulted either in a readmission to hospital or an outpatient visit after adenoidectomy were infections followed by general symptoms such as fever, pain and problems with food and fluid intake. Even when including these complications, postoperative readmissions and outpatient visits due to causes other than haemorrhage were rare. Only 127 (0.4%) of the outpatient visits and 17 (0.05%) of the readmissions had an ICD code specifically defining a postoperative complication of the T-code cluster. In addition to the T-codes, other ICD codes may also indicate a complication (such as infections, fever, pain, etc.). However, the rates of complications based on non-T-codes must be interpreted with caution considering the possibility that the given diagnosis was not related to the adenoidectomy per se. One example where the interpretation is particularly challenging is epistaxis, an ICD code that we chose to exclude from the definitions of postoperative haemorrhage. Epistaxis is a potential symptom of postoperative haemorrhage, and there is a possibility that this group contains cases that should have been coded as a postoperative haemorrhage (T81.2).

4.1. Implications for clinical practice and future research

As shown in this study, adenoidectomy is an operation associated with extremely low rates of severe postoperative complications. These results have implications for future studies on adenoidectomy, as the low complication rates will make it difficult to draw conclusions from studies with an insufficient number of patients. Even if statistically significant differences could be found, the total rates of haemorrhages would still mean that the impact in clinical practice would be doubtful. A prospective randomized trial would, for the same reasons, be extremely costly and time-consuming to perform.

4.2. Strengths and limitations

The use of medical registers for observational cohort studies is a cost-effective way of obtaining large study samples to research rare outcomes. This study contains data from 51 746 registered paediatric adenoidectomies, in Sweden from 2007 to 2017. The inherent multicentre design reduces the risk of selection bias. Adenoidectomies with concomitant tonsil- and non-ENT surgeries were excluded and the procedures were divided into groups to minimize the influence of confounding factors (i.e., complications of surgery other than adenoidectomy). A previous study by Ludvigsson et al. showed the high validity of the NPR [26]. The CDR is a nearly complete register of all deaths in the Swedish population where 96% of the individuals have a

specific underlying cause of death recorded, missing only cases with insufficient information in the death certificate (for example, older individuals for whom the exact cause of death is difficult to determine due to several chronic diseases and no autopsy performed) [27].

In this study, data were only collected for health care visits within 30 days of surgery. This timespan can create an underestimation of the true rate of complications. Although nearly all haemorrhages were identified within six days after surgery and the data indicate that revisits for haemorrhagic complications after 30 days are rare, late complications such as velopharyngeal insufficiency, chronic Eustachian tube dysfunction etc. are missing. Even though these complications are interesting, such a study would warrant a longer, and individual, follow-up (probably several years).

Observational studies based on data from health care registers always imply limitations. The possible parameters and outcome measures are already set by the register; for example, perioperative and early complications before discharge as well as the surgical technique is not registered in the NPR. The data are further dependent on accuracy from the reporting health care providers. There is a potential risk that health care contacts due to nonsevere complications will be registered with a non-T-cluster ICD code. Primary care as well as patient contact over the phone is not covered in the NPR.

5. Conclusions

To the best of our knowledge, this is the largest study to date to study postoperative morbidity and mortality rates after adenoidectomy. No deaths related to adenoidectomy were found. Severe complications, such as late postoperative haemorrhage after adenoidectomy, were rare, and haemorrhage resulting in RTT was even rarer. Overall, adenoidectomy should be considered a safe surgical procedure associated with few complications.

The highest rate of postoperative haemorrhage was observed the first day after surgery, and most haemorrhagic complications occurred within a week. The most frequently identified complication, postoperative haemorrhage excluded, was postoperative infections. Comparisons with studies on tonsil surgery clearly show that adenoidectomy is associated with substantially lower postoperative morbidity.

Declaration of competing interest

The authors have no financial relationships or conflict of interest to disclose. The funding organization had no influence on study design or execution.

Acknowledgements

The authors acknowledge Bengt Bengtsson from Statistiska Konsultgruppen for the statistical analysis. This study was supported by Futurum, Academy for Health and Care, Region Jönköpings län.

References

- [1] M. Anniko, Union of European medical societies, in: *Otorhinolaryngology, Head and Neck Surgery*, Springer, Heidelberg, 2010.
- [2] P.W. Flint, C.W. Cummings, *Cummings Otolaryngology : Head and Neck Surgery*, Mosby, St. Louis, Mo., 2010.
- [3] J.C. Watkinson, R. Clarke, Scott-Brown's otorhinolaryngology head and neck surgery : paediatrics, the ear, Skull Base 2 (2019).
- [4] M.T. van den Aardweg, M.M. Rovers, A. Kraal, A.G. Schilder, Current indications for adenoidectomy in a sample of children in The Netherlands, *B-ENT* 6 (2010) 15–18.
- [5] J. Haapkylä, G. Karevold, K.J. Kvaerner, A. Pitkäranta, Trends in otitis media surgery: a decrease in adenoidectomy, *Int. J. Pediatr. Otorhinolaryngol.* 72 (2008) 8 1207–1213.
- [6] A.G. Schilder, W. Lok, M.M. Rovers, International perspectives on management of acute otitis media: a qualitative review, *Int. J. Pediatr. Otorhinolaryngol.* 68 (2004) 1 29–36.
- [7] K. Thomas, D. Boeger, J. Buentzel, et al., Pediatric adenoidectomy: a population-based regional study on epidemiology and outcome, *Int. J. Pediatr. Otorhinolaryngol.* 77 (2013) 10 1716–1720.
- [8] C.H. Lee, W.C. Hsu, J.Y. Ko, T.H. Yeh, W.H. Chang, K.T. Kang, Epidemiology and trend of pediatric adenoidectomy: a population-based study in Taiwan from 1997 to 2012, *Acta Otolaryngol.* 137 (2017) 12 1265–1270.
- [9] H.G. Choi, J.H. Hah, Y.H. Jung, D.W. Kim, M.W. Sung, Influences of demographic changes and medical insurance status on tonsillectomy and adenoidectomy rates in Korea, *Eur. Arch. Oto-Rhino-Laryngol. : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 271 (2014) 8 2293–2298.
- [10] H. Gerhardsson, J. Stalfors, E. Odhagen, O. Sunnergren, Pediatric adenoid surgery in Sweden 2004-2013: incidence, indications and concomitant surgical procedures, *Int. J. Pediatr. Otorhinolaryngol.* 87 (2016) 61–66.
- [11] A.J. Schupper, J. Nation, S. Pransky, Adenoidectomy in children: what is the evidence and what is its role? *Current otorhinolaryngology reports* 6 (2018) 1 64–73.
- [12] C.J. Skilbeck, D.J. Tweedie, A.R. Lloyd-Thomas, D.M. Albert, Suction diathermy for adenoidectomy: complications and risk of recurrence, *Int. J. Pediatr. Otorhinolaryngol.* 71 (2007) 6 917–920.
- [13] S. Sarny, G. Ossimitz, W. Habermann, H. Stammberger, Hemorrhage following tonsil surgery: a multicenter prospective study, *Laryngoscope* 121 (2011) 12 2553–2560.
- [14] A. Tomkinson, W. Harrison, D. Owens, S. Fishpool, M. Temple, Postoperative hemorrhage following adenoidectomy, *Laryngoscope* 122 (2012) 6 1246–1253.
- [15] D. Lowe, P. Brown, M. Yung, Adenoidectomy technique in the United Kingdom and postoperative hemorrhage, *Otolaryngology–head and neck surgery, official journal of American Academy of Otolaryngology–Head and Neck Surgery* 145 (2011) 2 314–318.
- [16] J.P. Windfuhr, G. Schloendorff, A.M. Sesterhenn, A. Prescher, B. Kremer, A devastating outcome after adenoidectomy and tonsillectomy: ideas for improved prevention and management, *Otolaryngology–head and neck surgery, official journal of American Academy of Otolaryngology–Head and Neck Surgery* 140 (2009) 2 191–196.
- [17] L.W. Pratt, R.A. Gallagher, Tonsillectomy and adenoidectomy: incidence and mortality, 1968–1972, *Otolaryngol. Head Neck Surg.* 87 (1979) 2 159–166.
- [18] K.A. Brown, R.T. Brouillette, The elephant in the room: lethal apnea at home after adenotonsillectomy, *Anesth. Analg.* 118 (2014) 6 1157–1159.
- [19] National Patient Register. <https://www.socialstyrelsen.se/en/statistics-and-data/registers/national-patient-register/>. (Accessed 10 February 2022). Accessed.
- [20] Cause of death register. <https://www.socialstyrelsen.se/statistik-och-data/register/dodsorsaksregistret/>.
- [21] Nomesco Classification of Surgical Procedures, 2011, in: <https://nhwstat.org/publications/ncsp-classification-surgical-procedures>.
- [22] E. Østvoll, O. Sunnergren, E. Ericsson, et al., Mortality after tonsil surgery, a population study, covering eight years and 82,527 operations in Sweden, *Eur. Arch. Oto-Rhino-Laryngol. : official journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS) : affiliated with the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 272 (2015) 3 737–743.
- [23] E. Østvoll, O. Sunnergren, J. Stalfors, Increasing readmission rates for hemorrhage after tonsil surgery: a longitudinal (26 Years) national study, *otolaryngology–head and neck surgery, official journal of American Academy of Otolaryngology–Head and Neck Surgery* 158 (2018) 1 167–176.
- [24] E. Odhagen, J. Stalfors, O. Sunnergren, Morbidity after pediatric tonsillectomy versus tonsillectomy: a population-based cohort study, *Laryngoscope* 129 (2019) 11 2619–2626.
- [25] F. Paulsen, B. Tillmann, C. Christofides, W. Richter, J. Koebke, Curving and looping of the internal carotid artery in relation to the pharynx: frequency, embryology and clinical implications, *J. Anat.* (2000) 373–381. Pt 3.
- [26] J.F. Ludvigsson, E. Andersson, A. Ekblom, et al., External review and validation of the Swedish national inpatient register, *BMC Publ. Health* 11 (2011) 450.
- [27] H.L. Brooke, M. Talbäck, J. Hörnblad, et al., The Swedish cause of death register, *Eur. J. Epidemiol.* 32 (2017) 9 765–773.