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Original Article

Diurnal variation of post-tonsillectomy haemorrhage

Peter Bill Juul Ladegaard[1, 2], Knud Larsen[2] & Anette Drøhse Kjeldsen[1]

1) Department of Otolaryngology, Head and Neck Surgery, Odense University Hospital, 2) Head and Neck Surgery, Hospital of Southwestern Denmark, Denmark

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ABSTRACT

INTRODUCTION. Post-tonsillectomy haemorrhage (PTH) is typically self-limiting but may require medical intervention or surgery. PTH is classified as either primary (within 24 hours) or secondary (after 24 hours). Secondary haemorrhage is often linked to eschar sloughing, though the exact cause remains unclear. Secondary PTH is often an out-of-office-hour event. We aimed to investigate the diurnal variations of PTH in a Danish cohort.

METHODS. This retrospective cohort study recruited patients from ear-nose-throat (ENT) departments in the Region of Southern Denmark from January 2017 to December 2021. Patients with the International Classification of Diseases, tenth version (ICD-10) codes related to tonsillectomy (emb 10, -15, -20, and -99) combined with the post-operative haemorrhage ICD-10 (DT810) were included in the study. The exclusion criteria were haemorrhage other than PTH and misclassification. The exact time and date for hospital arrival were assigned in three-hour slots. The primary outcome was diurnal variation. Secondary outcomes included the severity of PTH, among other demographic variations. The data were evaluated by a χ^2 test.

RESULTS. A total of 459 contacts were analysed, corresponding to a PTH contact rate of 8%. Hereof, 382 events had active PTH (6.7%). When only secondary PTH (n = 375) were considered, the diurnal PTH contacts fluctuated significantly; nocturnal events (9 PM-9 AM) accounted for 233 hospital contacts (62%).

CONCLUSIONS. We found that PTH contacts were more frequent at nighttime, highlighting the need for vigilance to optimise healthcare resources and patient safety. Further research on PTH aetiology is needed.

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Tonsillectomy is a common surgical procedure indicated for conditions such as recurrent tonsillitis, halitosis and obstructive sleep apnoea (OSA). Post-tonsillectomy haemorrhage (PTH) is the most frequently reported complication, occurring in 2-15% of cases [1-4]. In Denmark, PTH is diagnosed by otorhinolaryngologists, general practitioners (GPs) and emergency healthcare personnel. It is classified as primary (within 24 hours of surgery) or secondary (after 24 hours) [5]. Secondary haemorrhage is often attributed to surgical technique (e.g. hot dissection), tonsil bed infection, sloughing of the tonsillar eschar or non-steroidal anti-inflammatory drug (NSAID) use. However, the exact causes remain unclear [6, 7]. Secondary PTH most commonly occurs between the fifth and tenth post-operative day [2].

Although many PTH episodes may resolve spontaneously and never reach medical attention, a significant proportion require intervention, occasionally requiring emergency surgery (ES). Despite efforts to modify surgical techniques, NSAID restriction, etc., the PTH rates remain unchanged [1, 8-10]. Comprehensive patient

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education on bleeding risk and patterns is standard care, with guidelines covering analgesia, diet and medical leave. However, data on diurnal PTH patterns remain limited, despite anecdotal reports of increased nocturnal incidence [11]. Moreover, this knowledge may aim to address the suggested mechanism of sloughing of the tonsillar eschar during heavy mouth breathing and snoring while sleeping as a contributor to PTH.

In recent years, few studies of diurnal variation in PTH have emerged. Kim et al. were the first group to report diurnal variations in PTH. In their cohort of 98 patients, 60 had documented exact bleeding time. Among these patients, 45 arrived at the emergency department during the evening (6 PM-12 AM) or overnight (12 AM-6 AM) [12]. In 2021, Grasl et al. focused only on cases requiring ES and found that 65% of PTH cases occurred in the 6 PM-6 AM interval, increasing to 81% for PTH after the tenth post-operative day [13]. Most recently, Lancer et al. reviewed cases requiring ES, reporting that 50% of PTH events occurred during the night (10 PM-7 AM) [14].

The aim of the present study was to investigate patient characteristics and diurnal variations in a broad cohort of Danish PTH events.

Methods

We conducted a retrospective cohort study, recruiting patients from the four ear, nose and throat (ENT) departments in the Region of Southern Denmark (Vejle, Sønderborg, Odense/Svendborg and Esbjerg) between January 2017 and December 2021. Approval was obtained from the Danish regional health authorities (ID: 22/14911). Patients were identified by extracting International Classification of Diseases, tenth version (ICD-10) codes from the electronic patient journals (EPJ). The inclusion criteria comprised patients who had undergone tonsillectomy or other tonsil-related surgery (emb 10 = tonsillectomy, emb 20 = adenotonsillectomy, emb 15 = intracapsular destruction of tonsils (tonsillotomy) and emb 99 = other resections on tonsils) in combination with ICD-10 codes indicating post-operative haemorrhage (dt810) registered within two months after surgery. The exclusion criteria included haemorrhage from other causes, isolated adenoidectomy and misclassification.

All patient files with a tonsillectomy code and post-operative bleeding were manually evaluated by the first author (PBL).

The primary outcome was determining the time of day when the PTH event was recorded in the EPJ. Whenever achievable, this was cross-checked against the patient-reported time of PTH onset as documented in the EPJ. Time intervals were categorised into three-hour slots (00:00-03:00, 03:00-06:00, 06:00-09:00, 09:00-12:00, 12:00-15:00, 15:00-18:00, 18:00-21:00, and 21:00-00:00). PTH events were classified as either primary (≤ 24 hours) or secondary (> 24 hours). Secondary PTH was further stratified into four distinct subgroups: 1) Major PTH, PTH requiring ES for surgical haemostasis. 2) Minor active PTH, comprising PTH managed with medical treatment or other healthcare interventions. 3) Minor inactive PTH, denoting PTH instances with no medical or surgical intervention (e.g., only residual clot or no findings), and finally 4) Minor recurrent PTH, referring to patients with multiple healthcare encounters due to repeated bleeding episodes. This category was subsequently reclassified based on the first PTH event and included in the data of the most representative subgroup, whereas recurrent PTH involving ES at any time was classified as major PTH.

Secondary outcomes encompassed patient characteristics and subgroup analyses based on surgical indication: elective, OSA and acute tonsillectomy (e.g. peritonsillar abscess). These data were extracted using relevant ICD-10 codes (dg473, dj369). All additional relevant demographic information was systematically obtained from the EPJ.

Statistics

The data were collected and analysed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). A χ^2 goodness of

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fit test was used to evaluate the diurnal variations in reported PTH events and to assess discrepancies in time distribution between patient-reported and EPJ-recorded PTH onset. A multivariate logistic regression analysis was performed to identify clinical predictors of nocturnal PTH, with the dependent variable defined as nocturnal bleeding (21:00-09:00) versus daytime bleeding (09:00-21:00). Primary PTH events were excluded from this analysis. Predictors included sex, age group, smoking status, BMI ≥ 30 kg/m^2, surgical technique and number of days since surgery. A significance level of $p < 0.05$ was chosen.

Trial registration: not relevant.

Results

Patient selection, incidence and characteristics

A total of 5,766 tonsillectomies were performed during the study period (2,538 males, 3,228 females), with 459 PTH-related hospital contacts (8.0%). Primary PTH accounted for 1.5%, whereas secondary PTH constituted 6.5%. Among secondary cases, 2.4% required ES (major PTH), and 4.1% were classified as minor PTH – of which one-third (1.3%) were inactive (**Table 1**).

TABLE 1 Post-tonsillectomy haemorrhage (PTH), events and incidences.

	Cases, n	Incidence: n/N, %	Tonsillectomy procedures, N[a]
PTH, all cases	459	8.0	5,766
PTH, active haemorrhage	386	6.7	-
Primary PTH[b]	84	1.5	-
Secondary PTH[c]	375	6.5	-
Major[d]	141	2.4	
Minor:[e]	234	4.1	
Active[f]	162	2.8	
Inactive[g]	72	1.3	
PTH, females	253	7.8	3,228
PTH, males	206	8.1	2,538
PTH, age ≤ 12 yrs	55	3.5	1,560
PTH, age 13-25 yrs	200	9.5	2,092
PTH, age 26-40 yrs	136	12.7	1,064
PTH, age > 40 yrs	66	6.2	1,050
PTH, elective tonsillectomies[h]	396	7.9	4,999
PTH, acute tonsillectomies: peritonsillar and parapharyngeal abscess, acute tonsillitis and mononucleosis	64	8.5	767
PTH, sleep apnoea	45	9.9	454

a) Procedures include emb10 = tonsillectomy, emb 20 = adenotonsillectomy, emb 15 = intracapsular destruction of tonsils: tonsillotomy, and emb 99 = other resections on tonsils.
b) PTH < 24 h.
c) PTH > 24 h.
d) PTH requiring emergency surgery.
e) No requirements of emergency surgery.
f) Managed with medical treatment or healthcare interventions alone.
g) No active bleeding; no medical or surgical intervention needed, e.g., only residual clot or no findings.
h) Acute tonsillectomies excluded.

PTH occurred in 8.1% of males and 7.8% of females. The highest frequency was seen in patients aged 12-26 years (46% of cases), followed by those aged 26-40 years. Incidence by age group was: < 12 years: 3.5%, 12-26 years: 9.5%, 26-40 years: 12.7%, > 40 years: 6.2%. A total of 24% were smokers and 24% had a BMI ≥ 30 kg/m^2 (30% of those ≥ 35 kg/m^2). Cold steel dissection was used in 91% of surgeries, with bipolar or monopolar cautery permitted for haemostasis. Nineteen PTH cases followed surgery for oropharyngeal cancer.

Secondary PTH most commonly occurred between post-operative days 4-7 (60%), with day six being the most frequent. Only 7% occurred after day ten (**Figure 1** A).

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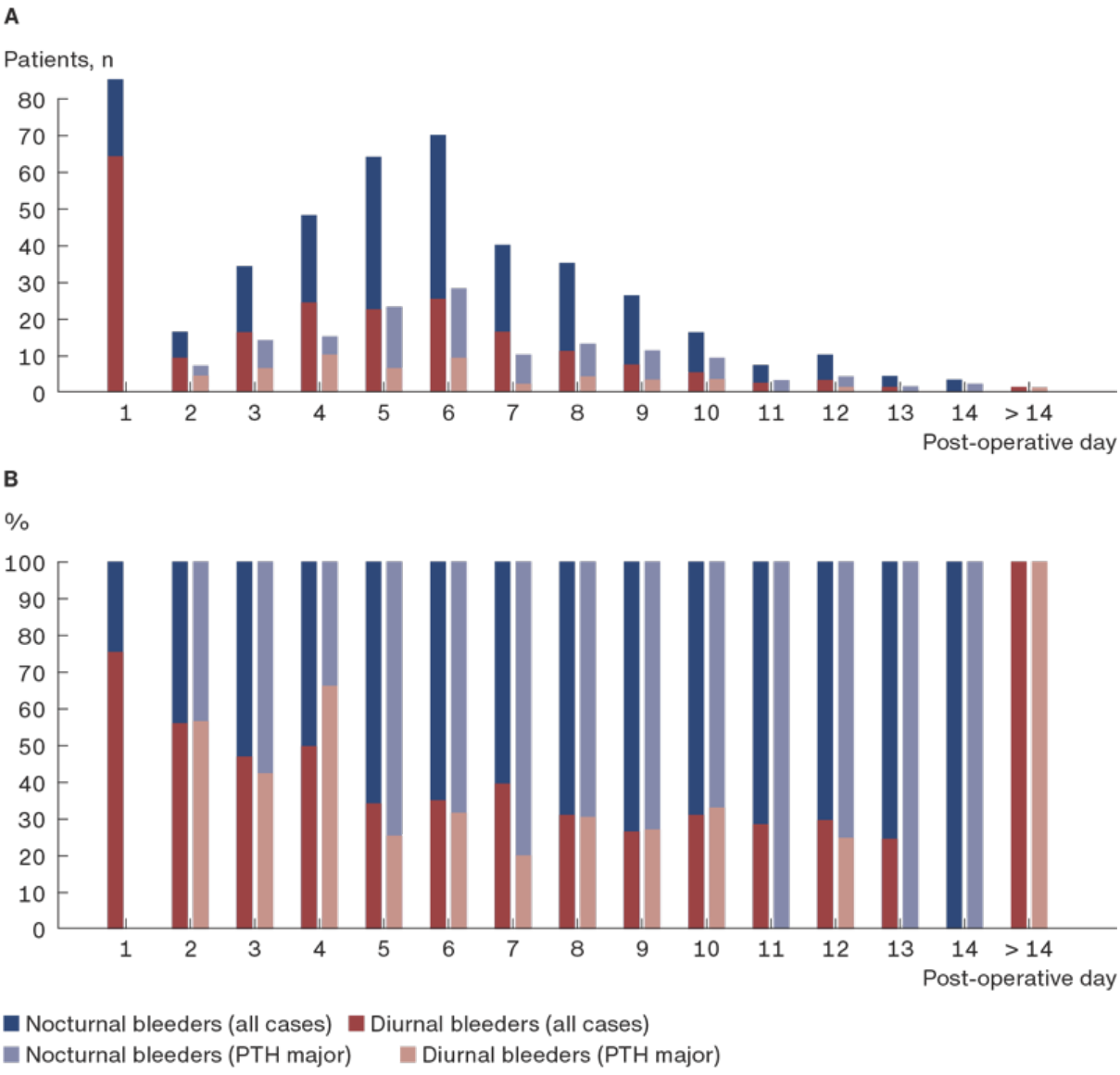
FIGURE 1 A. Onset of post-tonsillectomy haemorrhage (PTH) relative to the post-operative day and classified as a diurnal (09.00-21.00) or nocturnal (21.00-09.00) event. Shaded bars indicate PTH major only. **B**. Proportional distribution of diurnal and nocturnal bleeders by post-operative day.



By indication, haemorrhage rates were 7.9% (elective), 8.5% (acute) and 9.9% (OSA) (Table 1). Acute cases showed higher secondary (8.1%) and major PTH (3.7%) rates, whereas primary PTH was more common in OSA (3.3%). Only eight PTH events due to tonsillotomies were registered - two resulting in major PTH.

Time of the day variations

The diurnal distribution of PTH events is shown in **Table 2**. Overall, 62% of secondary PTH events occurred during the night (21:00-09:00, $p < 0.05$), rising to 65% for major PTH cases. Only inactive minor PTH showed no time-related variation.

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TABLE 2 Post-tonsillectomy haemorrhage (PTH) relative to time of the day, registered as three-hour clock intervals of the first journalised report in the electronic patient journal.

	Time, n (%)											
PTH subset	00.00-03.00	03.00-06.00	06.00-09.00	09.00-12.00	12.00-15.00	15.00-18.00	18.00-21.00	21.00-24.00	diurnal: 09-21	nocturnal: 21-09	p value[a]	Total, n (%)
All events	61	59	65	40	48	61	57	68	206	253	< 0.5	459
All events												
Primary PTH	3	4	3	4	10	27	23	10	64 (76)	20 (24)	< 0.05	84 (18)
Secondary PTH	58	55	62	36	38	34	34	58	142 (38)	233 (62)	< 0.05	375 (82)
Major PTH	28	21	25	10	18	11	10	18	49 (35)	92 (65)	< 0.05	141 (31)
Minor active PTH	22	25	29	15	13	20	13	25	61 (38)	101 (62)	< 0.05	162 (35)
Minor inactive PTH	8	9	8	11	7	3	11	15	32 (44)	40 (56)	0.32	72 (16)
Acute tonsillectomies												
Primary PTH	0	0	0	0	0	1	2	0	3	0	-	3
Secondary PTH	8	15	6	4	6	5	5	12	20	41	< 0.05	61
Major PTH	5	10	2	2	4	0	1	5	7	22	< 0.05	29
Minor active PTH	2	5	4	1	1	4	3	6	9	17	< 0.05	26
Minor inactive PTH	1	0	0	1	1	1	1	1	4	2	-	6
Obstructive sleep apnoea												
Primary PTH	0	0	0	0	0	5	8	1	13	1	< 0.05	14
Secondary PTH	5	4	3	2	2	4	5	6	13	18	< 0.05	31
Major PTH	3	2	2	0	1	0	2	3	3	10	< 0.05	13
Minor active PTH	2	2	1	2	1	4	1	2	8	7	0.71	15
Minor inactive PTH	0	0	0	0	0	0	2	1	2	1	-	3
Children age ≤ 12 yrs												
Primary PTH	1	0	1	1	4	6	3	1	14	3	< 0.05	17
Secondary PTH	4	3	8	4	7	1	3	8	15	23	0.11	38
Major PTH	3	0	5	2	2	1	1	2	6	10	0.15	16
Minor active PTH	0	2	1	0	0	0	1	2	1	5	-	6
Minor inactive PTH	1	1	2	2	5	0	1	4	8	8	1	16

a) χ^2 goodness of fit test.

Acute tonsillectomies demonstrated the most pronounced diurnal pattern, with 67% of secondary and 71% of major PTH episodes occurring during the night ($p < 0.05$). The OSA subgroup followed a similar trend, though primary PTH events were more common. In children under 12 years (n = 55), no significant diurnal variation was observed.

The multivariate logistic regression identified days since surgery as the only significant predictor of nocturnal PTH (odds ratio (OR) = 1.21; 95% CI: 1.13-1.30; p = 0.016). No other clinical variables were significant when assessing predictors for nocturnal admissions (Supplementary Figure). Figure 1 A illustrates the distribution of diurnal versus nocturnal bleeding across the post-operative period. From post-operative day five onward, a relatively higher proportion of nocturnal bleeding episodes was observed (Figure 1 B). This trend was evident in all cases as well as in the PTH major subgroup.

Patient-reported bleeding times matched the EPJ records in 76% of cases. In 17% of cases, patients reported a different onset time; in 7%, data were unachievable. The sensitivity analysis, however, showed a difference in diurnal patterns between matched cases and the full cohort ($\chi^2 = 15.52$, p = 0.030) (**Figure 2**).

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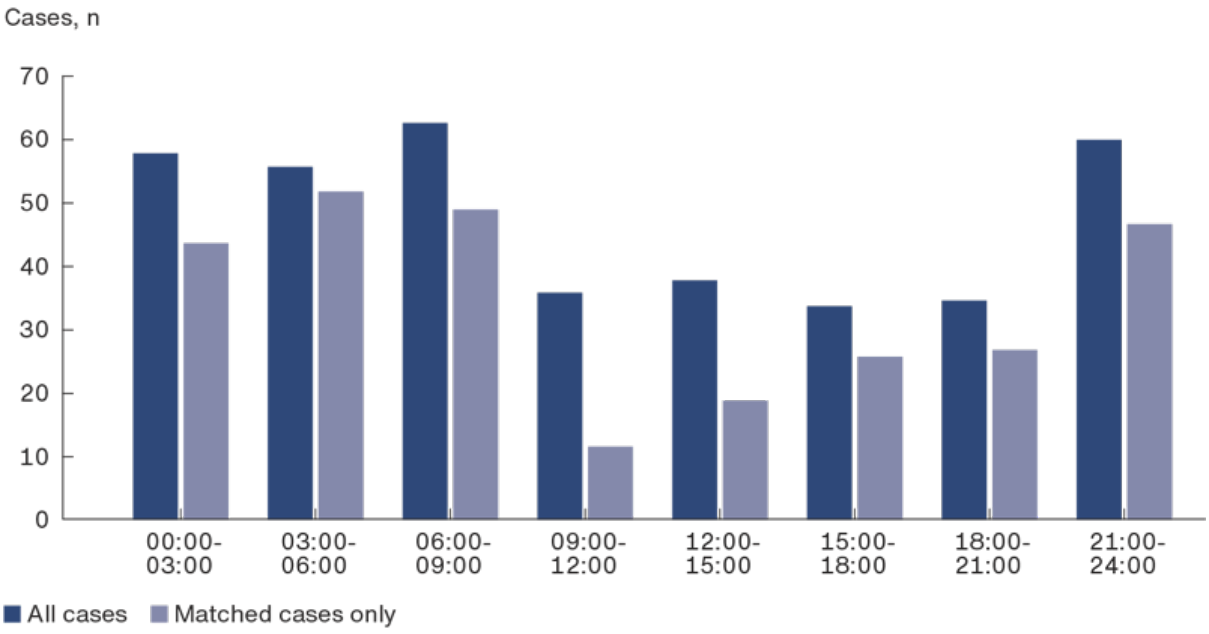
FIGURE 2 Diurnal variation of secondary post-tonsillectomy haemorrhage (PTH) episodes in all cases compared to cases with matched time intervals between electronic patient journal documentation and patient-reported PTH onset. A χ^2 test ($p = 0.03$) was conducted to assess whether the distribution of bleeding episodes over time differed between matched cases and all cases.



Discussion

To our knowledge, this study represents the first and largest investigation encompassing all types of PTH events in relation to diurnal patterns. We observed a significant diurnal PTH variation in hospital contacts across all subgroups, except for inactive PTH cases and PTH cases in children below 12 years, both of which demonstrated a more balanced pattern of hospital visits throughout the day. The most notable discrepancy was observed in the major PTH subgroup, particularly among patients who initially underwent acute tonsillectomy, but still did not present as a significant predictor of nocturnal PTH. Our study findings are comparable to those of other studies focusing on diurnal PTH variations. Both Lancer et al. and Grasl et al. found significant time-of-day variations in PTH, favouring nocturnal hospital admissions [13, 14]. In the Kim et al. group, an even higher proportion of PTH visits occurred during the evening and nighttime (75%), but only among patients who reported the exact hourly onset of PTH [12]. In the full cohort, the PTH variation in the 6 PM-6 AM interval was estimated at 61%, aligning closely with our and other studies' findings [12, 14].

Another notable finding was that the number of days since surgery had a significant impact on the relative distribution of diurnal versus nocturnal hospital admissions, suggesting a potential aetiological attribution to late-onset PTH events. A similar pattern was reported in the study by Grasl et al., which found a significantly higher proportion (80.6%) of nocturnal admissions (6 PM-6 AM) after the tenth post-operative day [13].

Compared to other studies focusing on PTH incidences, we found a higher PTH rate. For instance, Lancer et al.'s study, which only included PTH cases with ES, reported a PTH rate of 1.4%. In contrast, our study suggests a proportion of 2.4% needing ES. Doshi et al. conducted a prospective study in a British cohort and found that patient-reported PTH rates (15.7%) were nearly three times higher than hospital-reported rates (5.7%), mainly

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because patients sought care from their GPs rather than hospitals [3]. The accessibility of the Danish hospital system, being free and convenient, may lead to more PTH hospital contacts in our cohort. Additionally, access to anaesthetic services outside of regular office hours is also readily available in the Danish healthcare, which may contribute to the higher rates of major PTH. Liu et al. also investigated the various reports on PTH incidences in children. In their opinion, the variation in PTH was due to a lack of standardised criteria for reporting of PTH events. Some authors prefer to report PTH based on the need for ES, whereas others count incidents with visible blood from tonsillar beds [15]. In our study, we also observed significant variations in PTH incidence based on age. The low incidence in children under 12 years may be due to the frequent use of tonsillotomy, which has a lower PTH rate, as shown in systematic reviews [16]. Overall, only eight PTH events occurred following tonsillotomy in our cohort. However, due to inconsistent documentation by physicians, the total number of tonsillotomy procedures could not be determined, highlighting the need for prospective databases. Additionally, many PTH events in children under 12 years were inactive (16/55), with some visits likely being driven by parental concern.

A strength of our study is the cross-validation of the documented time of PTH events in the medical records with the patient-reported onset of bleeding. In 76% of cases, the EPJ-recorded time corresponded with the patient's reported bleeding time, suggesting that patients are generally admitted promptly and efficiently. These data align with the study by Kim et al., where approximately 61% of patients accurately recalled the exact hourly time of PTH onset. The time recorded in the EPJ appears to serve as a reliable indicator of PTH onset. However, the sensitivity analysis revealed a significant difference in the diurnal distribution of PTH, suggesting that unmatched patient-reported data may introduce bias when evaluating diurnal patterns. Validation studies are needed to confirm these findings. Another strength of our study is the large sample size combined with a detailed analysis of subgroups. No other studies have explored patient characteristics in relation to diurnal PTH onset.

An obvious limitation of the present study is its retrospective design. Some of the categorised minor PTH cases might have shown minimal haemorrhage, being classified merely due to limited medical intervention. Treatment guidelines are not well-defined, leading to significant inter-therapeutic variability in PTH treatment. In Denmark, junior doctors often deal with the initial assessment of PTH patients, which may result in overtreatment, including ES. However, this is only an assumption, and more research is needed to confirm this statement.

This study also raises the question of why acute tonsillectomies show a higher propensity for ES and nocturnal PTH. One explanation could be the presence of an ongoing infection, while another might be the readiness to use hot dissection/haemostasis during the initial surgery, which could hypothetically lead to necrosis and the formation of more abundant eschars over tonsillar beds over time.

Conclusions

We found that PTH contacts more frequently occur at nighttime, highlighting the need for vigilance during "out-of-office hours" to optimise healthcare resources and patient safety. Clear patient and caregiver guidance on rebleeding timing and hospital contact is essential. Further research is needed to explore the causal relationship between PTH and diurnal variations.

Correspondence *Peter Bill Juul Ladegaard*. E-mail: peterjuulladegaard@gmail.com

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