SAFE DELIVERY OF PAEDIATRIC ENT SURGERY IN THE UK: A NATIONAL STRATEGY

A Report of a Combined Working Party of the British Association for Paediatric Otolaryngology (BAPO), ENT UK, The Royal College of Anaesthetists (RCoA) and the Association of Paediatric Anaesthetists of Great Britain and Ireland (APAGBI)

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Hospital Definitions

Secondary Centre

A secondary care centre is a district general hospital without paediatric intensive care facilities. It is recognised that some of the secondary care centres have a higher level of high dependency provision and therefore can accept a wider range of children for surgery. These are referred to as high acuity secondary centres and incorporate PICS Level 2 Critical Care. (2)

Tertiary Centre

A tertiary care centre is a hospital with full paediatric facilities including PICS Level 3 Critical Care. (2)

Introduction

In recent years there has been a significant change in UK practice of Paediatric ENT surgery with many more children being referred to tertiary centres. This strategy has a number of unintended consequences. Patients and families are travelling further for treatment, incurring both social and financial cost. Fewer procedures are being performed in secondary care centres, which can result in reduced confidence in dealing with both elective and emergency paediatric cases. Tertiary centres are now commonly being faced with a situation where they have no beds to accept specialist referrals as emergencies. Waiting lists are increasing in tertiary centres.

In 2018, Mr Brian Bingham, President of ENT UK, asked Mr Benjamin Hartley, President of the British Association for Paediatric Otolaryngology, to set up a working group, in association with the Royal College of Anaesthetists, to examine the need for onward referral or transfer and establish a National Strategy for Paediatric ENT Surgery in the UK.

Background and Aims

Paediatric ENT surgery is among the commonest elective children's surgery in the UK. It has been widely practised at district general hospitals for many years. Recent developments have seen changes in hospital regulation for paediatric services and a requirement for further competencies to practice aspects of paediatric anaesthesia. These changes have led to an increase in referral to specialist centres for children undergoing routine elective ENT procedures. There is a lack of guidance in this area particularly with regard to minimum age and weight which are the most frequently quoted reason for referral to a tertiary centre.

A previous working party set out to try and establish which children in the UK with sleep disordered breathing undergoing adeno-tonsillectomy should be referred to a tertiary centre with paediatric intensive care unit and which were safe for surgery in a secondary care centre (3), (4). The authors concluded that the evidence in this area was lacking and that severe respiratory events requiring PICU occur but are probably uncommon allowing the majority of children to be treated safely in a secondary care centre. A list of high-risk criteria was suggested. The authors reported that this was an interim working tool based on level 5 evidence. It was intended as a starting point to catalyse further development towards a structured evidence-based guideline.

This working group has revisited this issue as intended by the original authors. The previous authors suggested children under 2 years of age, and a weight of less than 15kg, with severe sleep-disordered breathing should be transferred from a secondary care centre for adeno-tonsillectomy. This guidance has been widely misinterpreted as a minimum age and weight for surgery in a secondary care centre and inappropriately applied to other children without sleep-disordered breathing undergoing ENT surgery. There is no evidence to support this.

In addition, there is a disparity between the figures of 2 years of age and weight of 15kg. The mean weight of a child age 2 years (50th centile) is 12.2kg for males and 11.4kg for females (5). The previous publication suggested weight of <15kg that was linked to possible increased risk of post-operative complications. This has resulted in very large numbers of healthy children in the 12-15kg range being transferred potentially unnecessarily. We set out to look at the data and the practice developments since this publication and to look not just at children with sleep-disordered breathing but all children undergoing paediatric ENT surgery.

The aim of this working group is to establish clear guidance for which children should be transferred to tertiary centres and which children can be safely treated closer to home.

The scope of this guidance is to frame the best location for the delivery, in terms of skill mix and facilities, for common ENT conditions. It is beyond the scope of the document to discuss how pathways should be managed within each hospital. Decisions regarding day surgery and overnight stay choices are at the discretion of local teams.

Current trends in Paediatric ENT Surgery

The perception of a flux of patients from secondary to tertiary care is supported by data. Getting It Right First Time (GIRFT) is a national programme designed to improve medical care within the NHS by reducing unwarranted variations. GIRFT use hospital episode statistics from NHS Trusts in England to determine variation(1). The statistics offer a unique insight into the distribution of paediatric tonsillectomy and the change from the year 2012-13 to 2016-17. Hospitals were divided into those with intensive care facilities (tertiary care) and those without (secondary care).

Tonsillectomy for tonsillitis in children remained relatively steady for this time period in tertiary care, with around 1000 cases per quarter, but in secondary care decreased by around 400 cases per quarter (Figure 1). By contrast tonsillectomy for hypertrophy of the tonsils (a code which may reflect obstructive sleep apnoea) remained steady for secondary care but increased by over 500 cases per quarter in tertiary care (Figure 2). This equates to an increase of 83% in a 5-year period. Tonsillectomy for sleep disorders showed an increase in numbers in both secondary and tertiary care (Figure3). The overall inference from this is that many more children with obstructive sleep apnoea are undergoing surgery in tertiary care centres than 5 years ago.

An analysis by age group confirms that younger patients are increasingly having their surgery in tertiary centres. Around 300 more children per quarter who are aged 0-4 are having their surgery in these centres (Figure 4).

Analysis of tonsillectomy with (Figure 5) and without (Figure 6) adenoidectomy demonstrates that adeno-tonsillectomy, which is more likely to reflect obstructive sleep apnoea as a cause, is on the increase in tertiary centres.

A local analysis of coding data confirmed the geographic aspects of these trends in the Newcastle region. The secondary care catchment area for the hospital is captured by the NE postcode. Other regional postcodes have other secondary care providers. An analysis of tonsillectomies for this postcode and other postcodes was undertaken. In 2002-2003 14% of tonsillectomies had an NE postcode, but in 2017-2018, this had increased to 21%. This 50% increase is reflective of the perceived experience of other tertiary units around the country.

Figure 1

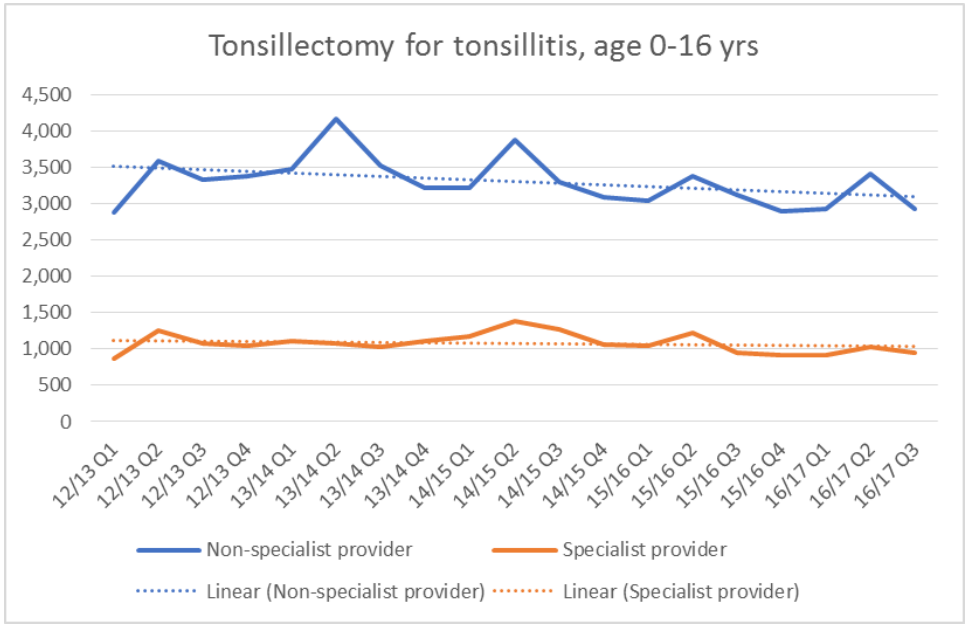


Figure 2

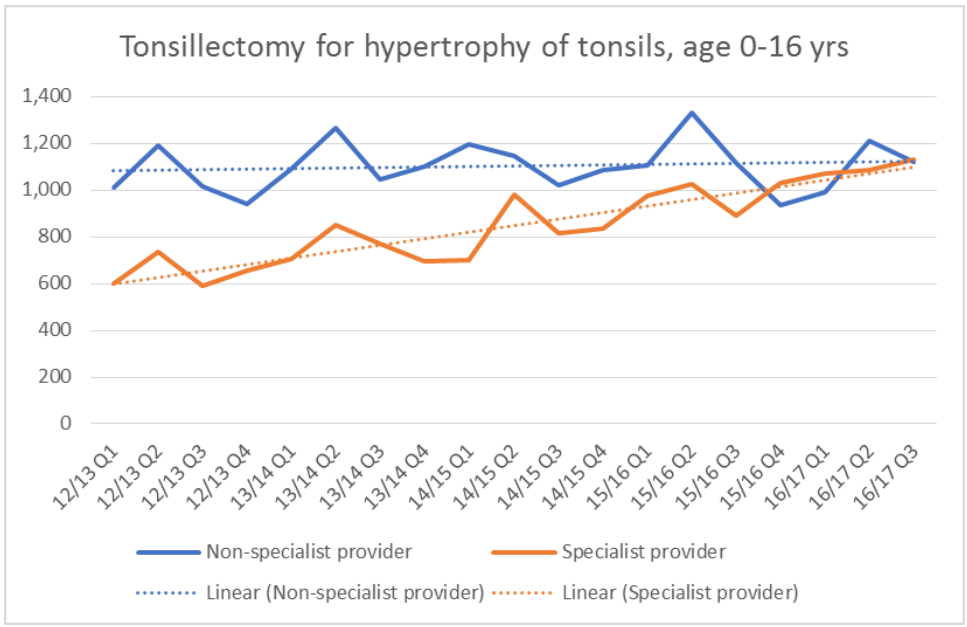


Figure 3

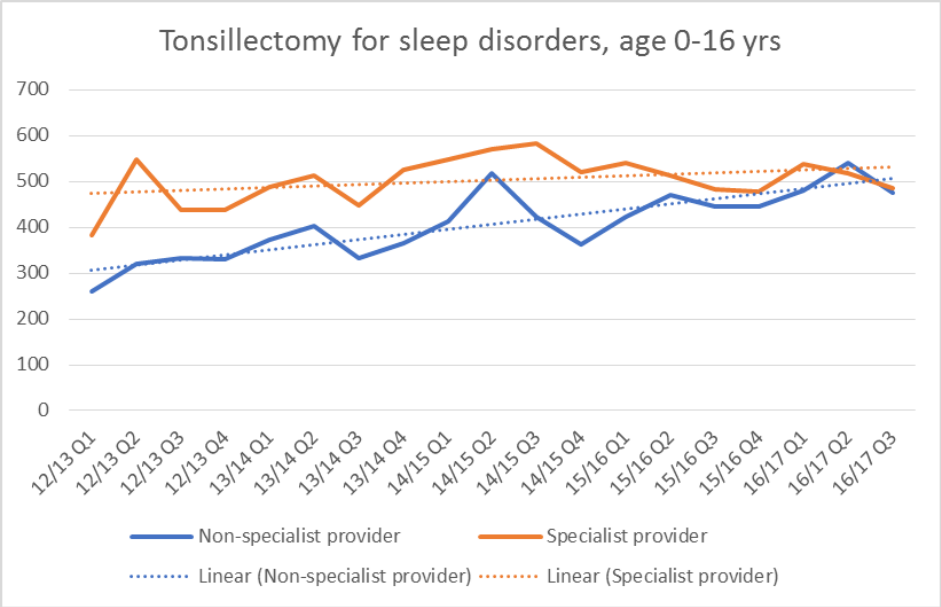

Tonsillectomy for sleep disorders, age 0-16 yrs
700
600
500
400
300
200
100
0
12/13 Q1
12/13 Q2
12/13 Q3
12/13 Q4
13/14 Q1
13/14 Q2
13/14 Q3
13/14 Q4
14/15 Q1
14/15 Q2
14/15 Q3
14/15 Q4
15/16 Q1
15/16 Q2
15/16 Q3
15/16 Q4
16/17 Q1
16/17 Q2
16/17 Q3
Non-specialist provider
Specialist provider
Linear (Non-specialist provider)
Linear (Specialist provider)

Figure 4

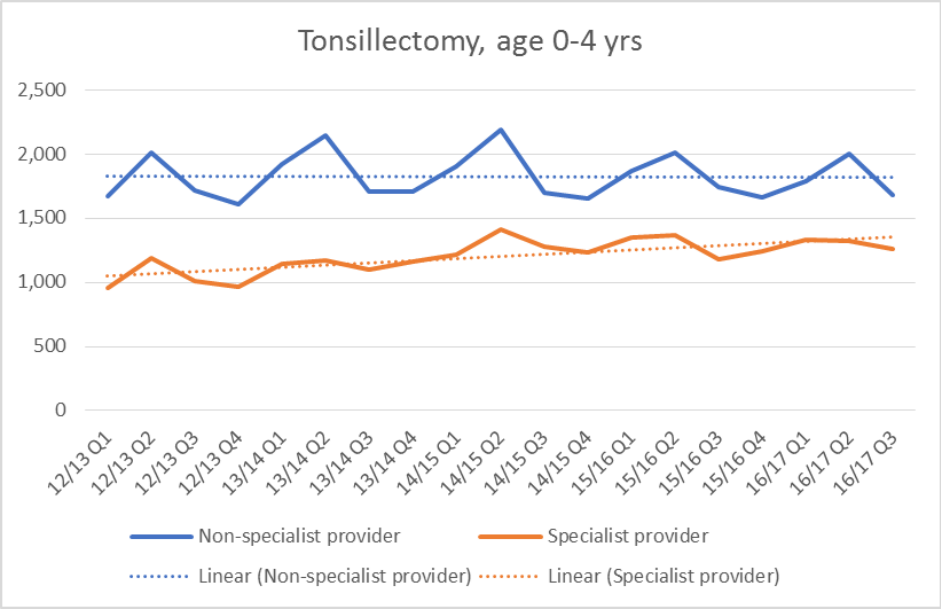

Tonsillectomy, age 0-4 yrs
2,500
2,000
1,500
1,000
500
0
12/13 Q1
12/13 Q2
12/13 Q3
12/13 Q4
13/14 Q1
13/14 Q2
13/14 Q3
13/14 Q4
14/15 Q1
14/15 Q2
14/15 Q3
14/15 Q4
15/16 Q1
15/16 Q2
15/16 Q3
15/16 Q4
16/17 Q1
16/17 Q2
16/17 Q3
Non-specialist provider
Specialist provider
Linear (Non-specialist provider)
Linear (Specialist provider)

Figure 5

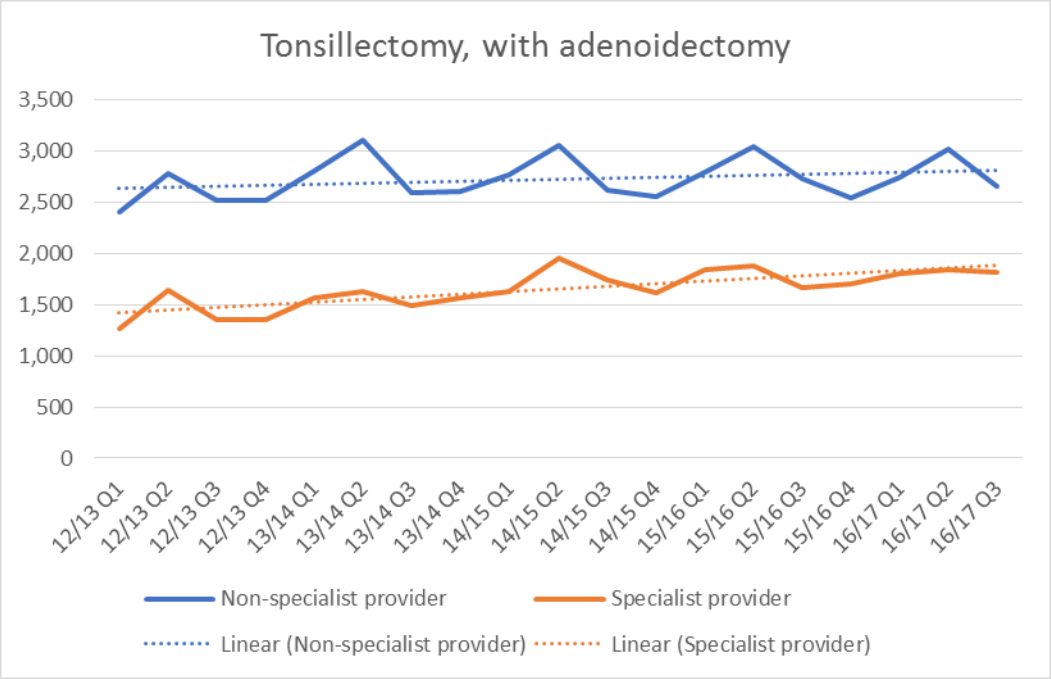
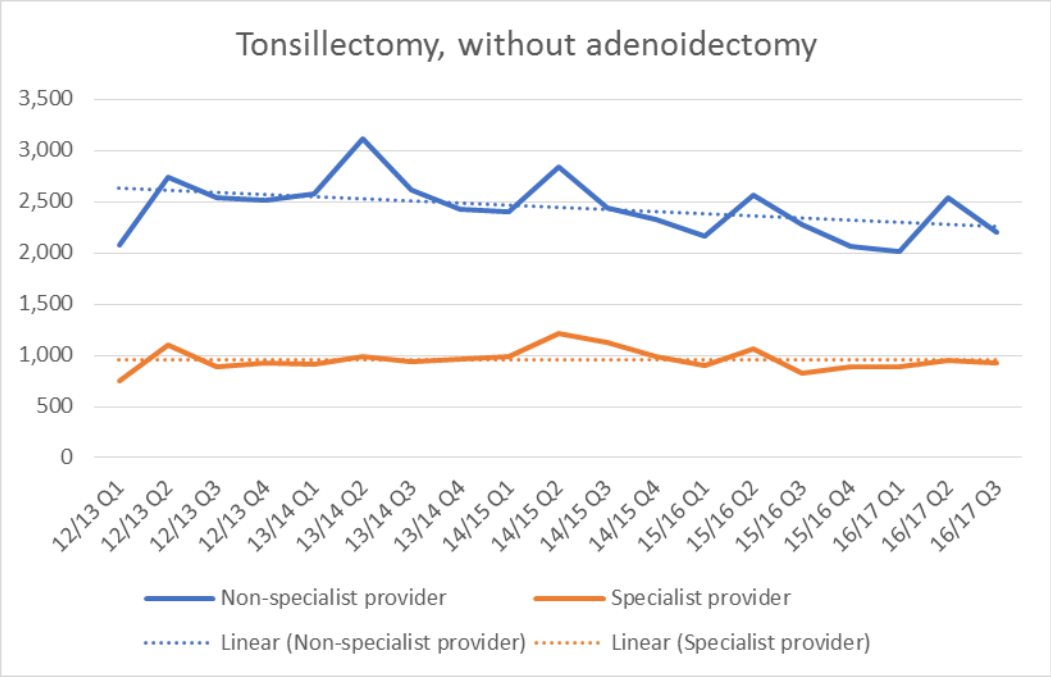


Figure 6



Section 1:

The Child with Sleep Disordered Breathing undergoing adeno-tonsillectomy in a Secondary Centre

A comprehensive literature review was carried out looking at post-operative complications in the younger children (Appendix 1). In addition, a review of UK adeno-tonsillectomy surgery in the under 3 years of age at Royal Manchester Children's Hospital, Evelina Children's Hospital London and similar data from Leeds Children's Hospitals (Appendix 2).

The commonest respiratory complication in all units was the need for post-operative oxygen (Appendix 1). This can be delivered in any hospital and is not a reason for transfer to a tertiary centre. The incidence of major complications in the literature varies but in a meta-analysis of 22 papers it was estimated to be 5.8%. (6). UK figures are frequently lower than this (7). The vast majority of these complications are predictable based on co-morbidity. Predictable complications allow for planned PICU availability and in general children who experienced major and minor respiratory complications make a full recovery. Unplanned PICU admissions are more concerning but fortunately very rare in all series. It is also noted that the use of the nasopharyngeal airway in certain centres has facilitated very low planned PICU admission rates (8). There is now increasing evidence to support day-case surgery in children less than 2 years without additional complications(9-12).
In current UK practice many units currently use a minimum age criterion of 3 years or minimum weight of 15kg for onward referral for children. The evidence for this is limited. Age and weight are not a predictor for PICU admission or prolonged admission, in absence of other risk factors (7), (13).

The working group having carefully examined all the evidence felt that it was reasonable to adjust the ages and weight previously recommended by Robb et al and this could safely facilitate wider practice of paediatric ENT in secondary centres.

Recommendations

These recommendations rely on good clinical networks within regions and robust appraisal and shared governance. They also depend on shared, multidirectional education and MDT team training to maintain competence, confidence and safety whilst providing better patient experiences closer to home.

Thorough assessment for younger children with symptoms of OSA should be delivered by an experienced anaesthetist and surgeon. Skilled nursing pre-assessment services should also be developed. Surgery and perioperative care including care on the post-anaesthetic care unit and on the ward should be delivered by a team with ongoing experience with young children and who maintain regular training.

1 Any secondary centre is able to treat children 2 years (corresponding weight 12kg) and over with no high risk-factors or extremes of BMI. The staff and equipment as recommended in the Guidelines for the Provision of Paediatric Anaesthesia Services (GPAS) 2019 document should be available (14).

2 If the secondary centre is a high acuity centre with HDU provision, then children 1 year (corresponding weight 10kg) and over can be treated in the absence of high-risk factors.

3 A Tertiary Centre can treat any child regardless of age, weight, co-morbidity or BMI extremes.

Table 1

Body Mass Index
Extremes of weight, above 99.6th BMI centile and below 0.4th BMI centile should go to a high acuity centre if no high risk factors or tertiary care if high risk factors.

Table 2

Risk Factors
Severe cerebral palsy
Achondroplasia
Neuromuscular disorders (moderately or severely affected)
Significant craniofacial anomalies
Mucopolysaccharidosis
Significant comorbidity (e.g. Complex or uncorrected congenital heart disease, Home oxygen, severe cystic fibrosis)
When onsite support from tertiary medical specialties is needed e.g. metabolic, haematology

Section 2. The normal child undergoing paediatric ENT surgery in a DGH with no co-morbidity (example middle ear ventilation tube insertion.)

There is no minimum age or weight for this group of children. There is a special requirement recognised in neonates 1-28 days although this is not relevant for common ENT surgery.

It is important that appropriate infrastructure, support services and staff training should be in place. All staff should work within their competency and experience.

Currently all anaesthetists with UK CCT will have undertaken high level paediatric training and are competent to manage children of 3 years of age and over and those who have acquired further competencies can safely anaesthetise younger children(14).

It is noted that under the current curriculum review it is the aspiration of the Royal College of Anaesthetists to reduce the age of competency for all UK CTT holders to manage children down to 1 year of age.

Section 3: Emergency Care

Emergency paediatric ENT surgery is not uncommon. There is a wide range from simple low risk procedures such as ear or nasal foreign bodies to more complex sometimes life-threatening conditions in need of urgent surgery such as laryngeal foreign bodies or button battery ingestion.

The current mechanism within the NHS for delivery of emergency surgery involves operational delivery networks (ODNs). The basic principle is that children should be treated as locally as possible provided that their needs can be met. More complex care can be dealt with more safely and efficiently by centralisation. In some specialities e.g. neonatology there is evidence of increased survival rates when patients with complex needs are treated in centres that see high volumes of similar cases. (15).

This has not however been demonstrated in paediatric ENT surgery and the advantages of centralisation need to be balanced against the risks of delay and the risks of transfer. It is noted that delivery of ODNs throughout different geographical regions in the UK is variable and this system relies on robust management of these networks.

In order for an emergency network to work safely and efficiently there needs to be good collaboration between the secondary and tertiary providers, common standards of care particularly around recognition of the seriously ill child, resuscitation and transfer arrangements(6-8). The Children's Forum of the RCS report, Standards for Non-specialist Emergency Care of Children 2015 was produced following a review and discussion of all available standards and guidance relating to paediatric emergency care over the previous 10 years (16). It is a comprehensive document detailing a best practice pathway, particularly highlighting

standards required for treating children in secondary care involving resuscitation, stabilisation and transfer. They establish a minimum generic standard for treating children within secondary and tertiary settings, but they are not prescriptive on who has to be transferred. There is no optimal design for local emergency services for ENT. The pathways produced by different regional ODNs will depend on access, workforce, quality, finance and the use of technology. There will always need to be local secondary services to deal with critically ill children including life-threatening situations, major haemorrhage and airway obstruction. It is therefore incumbent on all teams at local hospitals to comply with standards for resuscitation, recognition and management of critical, unstable conditions, and to arrange the appropriate transfer of complex patients. A consistent "treat or transfer" policy for each hospital will enable more consistency and clarity within the network and enable better service provision and strategic development at all network units.
A 'treat or transfer' toolkit for each network could be developed based on the following factors: Each hospital could be designated to a tier with a clearer understanding of what has to be provided at each level (Table 3).

One might expect that the gold standard should be that all patients have the highest level of care and resources, and that all patients should be transferred to the tertiary hospital. There is little data however to support that increased volumes in one unit directly result in better care for ENT as the relationship between quality and outcome is complex (17). The transfer of all emergencies to the tertiary unit may result in missed opportunities for safe and quick care locally in the secondary care units. Overburdening the transfer network and the tertiary unit would potentially result in increased risk associated with delays in care and other problems such as bed shortages and limited operating capacity.

With the emergence of operational delivery networks there needs to be clear guidance and standards on safe and sustainable patient pathways. The guiding principle should be that children with emergency ENT conditions should be treated at their local secondary care unit where it is safe to do so, but with clear guidelines indicating when they should be transferred to a specialist unit. Every hospital needs to be emergency safe for its local paediatric population and contribute to maintaining a successful ODN with a good balance between secondary and tertiary care.

Table 3

Tier 1 All hospitals receiving emergencies should be able to manage: Time critical / unstable condition (Any age): Major Haemorrhage Upper airway obstruction – stabilize an airway for transfer or remove a tracheal foreign body. Front of neck access / tracheostomy if necessary
Tier 2 Most 24 hours secondary care hospitals with paediatric inpatients and tertiary hospitals: (Age criteria will depend on anaesthetic, theatre and nursing expertise) Tier 1 criteria plus uncomplicated ENT emergency surgery on ASA1/2 children Examples Foreign Bodies in nose / ears / throat Drainage of superficial abscess (Where specialist imaging not necessary) Drainage of mastoid abscess (where no intracranial complications are suspected) Drainage of periorbital abscess
Tier 3 Tertiary hospital (with Neurosurgery, PICU, NICU, paediatric radiology, specialized paediatric services) All emergency children with complex airway, ENT infections with intracranial, skull base, Intra -orbital or deep neck space infections.

Recommendations: The Decision to Transfer for Emergency Paediatric ENT Surgery

The decision to transfer is not a simple one but it needs to be considered and not automatic. If a child needs emergency ENT surgery, it may be safe and appropriate to manage without transfer. It is not possible for this working party to make comprehensive recommendations in this area however it is recommended that, in making the decision to transfer, the following should be considered.

Anaesthetic factors

All UK trained anaesthetists are competent to manage children 3 years of age and over at CCT. If an anaesthetist who has acquired more advanced paediatric competencies is available and appropriate support services are in place such that the whole care pathway is compliant with the RCoA Guidance on the Provision of Paediatric Anaesthesia Services (GPAS 2019)

(https://www.rcoa.ac.uk/system/files/GPAS-2019-10-PAEDIATRICS.pdf), then the minimum age will reflect both this and the anaesthetist's level of training and ongoing practice. Neonates (0-28days) presenting for surgery are at higher risk and require specialist anaesthetic considerations.

It is noted that under the current curriculum review it is the aspiration of the Royal College of Anaesthetists to reduce the age of competency for all UK CTT holders to manage children to 1 year of age.

Surgical factors

Many surgeons are competent to manage children in a DGH. If further specialist surgical expertise or equipment is felt to be needed, then transfer should be arranged. Non-airway disease such as abscesses, periorbital cellulitis, simple mastoiditis, foreign bodies of the ear and nose and ingested or selected inhaled foreign bodies are examples of cases that can often be managed without transfer.

Hospital Factors

Some cases carry risk of acute respiratory deterioration post-operatively that might require a Level 2 or 3 Critical Care. These should be transferred if safe to do so. The risk of deterioration during transfer needs to be considered and some cases may be judged better treated locally and immediately. In some cases, transfer for other specialty input such as neurosurgery or cardiothoracic surgery may be needed.

Patient Factors

Some cases are acute emergencies where transfer risks further harm to the child and these should be treated locally as best judged by the local team. e.g. button battery ingestion or inhalation. Complex patients with high risk factors may need to be transferred for simple procedures.

Section 4 The Role of Sleep Studies and Respiratory Investigation

A full examination of the role and application of sleep investigations is beyond the scope of this document. The two principle respiratory investigations that are considered in a child with sleep disordered breathing are pulse oximetry and polysomnography (PSG).

Several studies have shown that pulse oximetry cannot exclude obstructive sleep apnoea. One study in children referred to a sleep laboratory found that amongst those with negative oximetry, 47% had obstructive sleep apnoea based on PSG (18). In view of the widely shown limitations pulse oximetry is not recommended as a routine screening tool for diagnosis alone prior to adeno-tonsillectomy in children with sleep disordered breathing. It is also a poor predictor of post-operative complications and is not routinely recommended as a screening tool for risk stratification.

In the US there are guidelines on the use of polysomnography (PSG). They state before determining the need for adeno-tonsillectomy the clinician should refer children with sleep-disordered breathing for polysomnography if they exhibit certain complex medical conditions such as obesity, Down syndrome, craniofacial abnormalities, neuromuscular disorders, sickle cell disease, or mucopolysaccharidosis(19). In addition, the clinician should advocate for polysomnography prior to tonsillectomy for sleep-disordered breathing in children without any of the comorbidities listed above for whom the need for surgery is uncertain or when there is discordance between tonsillar size on physical examination and the reported severity of sleep-disordered breathing. PSG is widely recognised as the gold standard for assessing sleep disordered breathing, however it is expensive, with limited availability and with significant inconvenience related to admission.

A meta-analysis has been performed to look at how to predict major respiratory complications (6) These were defined as events that required significant medical intervention for the patient by a physician or nursing staff, including re-intubation, continuous positive airway pressure (CPAP) therapy, Bi-level Positive Airway Pressure Therapy (BiPAP), insertion of a nasopharyngeal or oropharyngeal airway, bag mask ventilation, an un-planned admission, elevation of care to the ICU, pulmonary oedema, or death. Post-operative desaturations, supplemental oxygen requirements, or need for repositioning, were not included as major respiratory complications. Twenty-two studies were identified, age from 1.3-8.3 years. Estimated rate of major respiratory complications post adeno-tonsillectomy was 5.8%. Thirteen studies (59%) concluded that readily identified clinical factors were all that were necessary to predict respiratory complications following adeno-tonsillectomy. Seven studies (32%) concluded that both clinical factors and PSG results were helpful in predicting complications, and only two studies (9%) definitively concluded that PSG results were necessary beyond clinical factors to accurately predict post-operative respiratory complications. In a pooled analysis 8.9% of patients with major respiratory complication had a PSG with moderate or severe OSAS as the sole predictive factor of the post-operative complication with no other clinical predictive factor. The remaining patients each had a readily identifiable clinical predictor including

age of 2 or under, elevated BMI, syndromic diagnosis, cardiac history, history of prematurity, history of failure to thrive, history of asthma, or history of recent upper respiratory infection.

Combining this observation with the estimated major respiratory complication rate following adeno-tonsillectomy presented above (5.8%), it is therefore estimated that only 0.52% (5.8% multiplied by 8.9%) of unselected patients undergoing adeno-tonsillectomy would be expected to have a major respiratory complication and only moderate to severe OSAS on PSG and no other clinical predictors of this complication. Stated another way, a roughly estimated 192 pre-operative PSGs would have to be performed in unselected patients undergoing adeno-tonsillectomy to accurately identify one patient who would be expected to have a major respiratory complication after adeno-tonsillectomy with only PSG results of moderate to severe OSAS and no other clinical findings as a predictor of the complication. PSG is thus a poor predictor of PICU admission in the absence of co-morbidity.

Recommendations

1. Clinical assessment all that is required in decision making for adeno-tonsillectomy in the majority of children with sleep disordered breathing.
2. Pulse oximetry is not routinely recommended as a screening tool.
3. Polysomnography should be selectively used in cases with comorbidity or diagnostic uncertainly.

Conclusions and Summary Recommendations

Recent times have seen a trend towards centralisation of surgical care into major centres. The data we have examined confirms that paediatric ENT surgery has followed that trend. There has been a marked increase in the transfer of younger children to specialist centres often based on concerns about age and weight. This has had a significant impact on the secondary centres. In addition, large scale transfer of healthy children to the centres established for complex and specialist surgery has had an impact on the availability of beds to deliver those services.

If regular elective paediatric ENT operating sessions are established in a secondary care centre, then the advantages are far reaching. The predictable nature of paediatric ENT surgery and large numbers involved allow hospitals to develop regular paediatric surgical services. Paediatric nurses and theatre staff can be recruited. Anaesthetists can maintain their competency. When occasional urgent cases arrive, they can be accommodated with increased safety. The advantages of having this infrastructure can be extended to other paediatric surgical and diagnostic services. The hospital is far better placed to deal with emergencies when they arise, particularly the occasional case where immediate transfer is not possible. Families have the advantage of local care which they value very highly.

It is the overall conclusion of this working party that referral of children to tertiary centres has become too frequent and many cases that are currently transferred can be safely managed locally. This has many advantages for the children, their families and for the hospitals and local services. We would recommend that secondary centres continue to deliver paediatric ENT surgery where possible and hope that the recommendations of this report will support them in doing this and in continuing to provide a high quality and safe service.

Summary Recommendations

Section 1: The Child with Sleep Disordered Breathing undergoing adeno-tonsillectomy in a secondary centre

1. Any secondary centre is able to treat children 2 years (corresponding weight 12kg) and over with no high risk-factors or extremes of BMI. The staff and equipment as recommended in the Guidelines for the Provision of Paediatric Anaesthesia Services (GPAS) 2019 document should be available(14).

   If the secondary centre is a high acuity centre with HDU provision, then children 1 year (corresponding weight 10kg) and over can be treated in the absence of high-risk factors.

Section 2: The normal child undergoing paediatric ENT surgery in a DGH with no co-morbidity (example bilateral grommet insertion.)

There is no minimum age or weight for this group of children. There is special requirement recognised in neonates 1-28 days although this is not relevant for common ENT surgery.

It is important that appropriate infrastructure, support services and staff training should be in place. All staff should work within their competency and experience.

Currently all anaesthetists with UK CCT will have undertaken high level paediatric training and are competent to manage children of 3 years age and over and those who have acquired further competencies can safely anaesthetise younger children(14).

It is noted that under the current curriculum review it is the aspiration of the Royal College of Anaesthetists to reduce the age of competency for all UK CTT holders to manage children down to 1 year of age.

Section 3: Emergency ENT Surgery

The decision to transfer is not a simple one but it needs to be considered and not automatic. If a child needs emergency ENT surgery, it may be safe and appropriate to manage without transfer. It is not possible for this working party to make comprehensive recommendations in this area however it is recommended that, in making the decision to transfer, the following should be considered.

Anaesthetic factors

All UK trained anaesthetists are competent to manage children 3 years of age and over at CCT. If an anaesthetist who has acquired more advanced paediatric competencies is available and appropriate support services are in place such that the whole care pathway is compliant with the RCoA Guidance on the Provision of Paediatric Anaesthesia Services (GPAS 2019) (https://www.rcoa.ac.uk/system/files/GPAS-2019-10-PAEDIATRICS.pdf), then the minimum age will reflect both this and the anaesthetist's level of training and ongoing practice. Neonates (0-28days) presenting for surgery are at higher risk and require specialist anaesthetic considerations.

It is noted that under the current curriculum review it is the aspiration of the Royal College of Anaesthetists to reduce the age of competency for all UK CTT holders to manage children to 1 year of age.

Surgical factors

Many surgeons are competent to manage children in a DGH. If further specialist surgical expertise or equipment is felt to be needed, then transfer should be arranged. Non-airway disease such as abscesses, periorbital cellulitis, simple mastoiditis, foreign bodies of the ear and nose and ingested or selected inhaled foreign bodies are examples of cares that can often be managed without transfer.

Hospital Factors

Some cases carry risk of acute respiratory deterioration post-operatively that might require PICU and these should be transferred if safe to do so. The risk of deterioration during transfer needs to be considered and some cases may be judged better treated locally and immediately. In some cases, transfer for other specialty input such as neurosurgery or cardiothoracic surgery may be needed.

Patient Factors

Some cases are acute emergencies where transfer risks further harm to the child and these should be treated locally as best judged by the local team. e.g. button battery ingestion or inhalation. Complex patients with high risk factors may need to be transferred for simple procedures.

Section 4: The Role of Sleep Studies and Respiratory Investigation

1. Clinical assessment all that is required in decision making for adeno-tonsillectomy in the majority of children with sleep disordered breathing.
2. Pulse oximetry is not routinely recommended as a screening tool.
3. Polysomnography should be selectively used in cases with comorbidity or diagnostic uncertainly.

Appendix 1.

Table 1. Summary of evidence- age no risk factor

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Belyea, Chang, Rigby, Corsten, Hong (2014) (20)	Retrospective case-control study	127 pts < 3 yrs 127 pts >3<4 yrs	Between 24-30 months	Not reported	OSA	Haemorrhage - primary 0.0% - secondary 3.9% Dehydration 2.4% Total late complications: 6.3% < 3 yrs vs 5.5% > 3 yrs	Airway 3.1% < 3 yrs vs 3.1% > 3yrs No distinction between major/minor	1. No difference in complication rate between study group and control group 2. No comments on comorbidities 3. Advise: admission for < 3-year olds might not be necessary in all cases
Arambula, Xie, Whigham (2018) (21)	Retrospective case note review	133	5.3 yrs (±4.0)	51.9% (± 36.6)	OSA	Not reported	Major airway 11.2% Minor airway 37.5%	1. Mixed population (57% comorbidities) 2. Risk factor for severe vs mild event: low weight percentile-for-age (29.7% vs 49.1%) 3. No relation with age, pre-op PSG, comorbidities, time in PACU 4. Majority of minor airway complications occurred in PACU
Shapiro et al (1999) (22)	Retrospective case note review	307 50 < 2 yrs 257 > 2 yrs	30 months (±5)	14kg (±2)	Mixed (83% OSA)	Haemorrhage 2.9% Dehydration 3.3% No distinction between primary and secondary haemorrhage	No incidents reported - Mean PACU O_2 sat 98 ± 3 - Mean inpatient O_2 sat 95% ± 4	1. Limited data available: SpO2 levels available for 42% of inpatients 2. Old study 3. Age < 24 months did not impact on haemorrhage or dehydration rate 4. 194 pts day case procedure 5. Airway complication not reported/investigated
Hamada et al. (2015) (23)	Retrospective chart review	50 pts ≤ 3 yrs 97 pts 4-6 yrs	≤ 1 yr 5 pts ≤ 2 yr 14 pts ≤ 3 yr 31 pts	Not reported	OSA	Haemorrhage 8.0% vs 4.1% No distinction between primary and secondary haemorrhage	Chest X-ray changes 18.0% vs 11.3% No other airway complications reported	1. No statistical difference between < 3 yrs and > 3 yrs groups 2. Postoperative care not comparable to UK setting (routine 7-day admission postop) 3. Airway complication not reported/investigated

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Brown et al (2003) (24)	Retrospective database review	54 study group vs 44 control group	4.0 yrs (±2.4) vs 3.5 yrs (±1.9 yrs)	22.4 (±18.7) vs 18.9 (±8.4)	OSA - Study group: urgent, - Control group: elective	Not reported	Major airway 20.3% vs 6.8% Minor airway 40.7% vs 29.5%	1. Mixed population (46% comorbidities) 2. More comorbidities in study group and more severe OSA 3. Risk factor for postop medical intervention: - comorbidity - SaO2 nadir < 80% 4. No correlation between age < 3 years vs > years
Helmus, Rapids (1979) (25)	Retrospective record review and questionnaire	108	< 3 yrs 19 pts < 2 yrs 89 pts < 3 yrs	Not reported	Infections	Haemorrhage - primary: 0.0% - secondary: 3.7% Dehydration 0.9%	Airway 0%	1. Old study 2. Poor quality 3. Advise: AsTs in < 2 yrs can be performed safely
Werle, Nicklaus, Kirse, Bruegger (2003) (26)	Retrospective case note review	94	19.6 mnts (range 12-23)	47th percentile (± 33.7)	Mixed (54% OSA)	Haemorrhage - primary 1% - secondary 3.2%	- Major airway 7.4% (71% comorbidities) - Minor airway 28.7% (74% comorbidities) of which 18% O_2 < 4 hours and 48% O_2 < 12 hours	1. Mixed population (50% comorbidities) 2. Wide range in weight centile 3. 21% performed as day case 4. Advise: overnight stay, small percentage suitable for discharge after 4-6 hours
Slovik, Tal, Shapira, Tarasiuk, Leiberman (2003) (27)	Retrospective case note review	35	15.86 mnts (range 6-23)	Not reported	OSA	Haemorrhage - primary 2.9% - secondary 2.9% Dehydration 8.6%	Major airway 5.7% (2/35, both severe OSA) Minor airway 0.0%	1. Mixed population (40% comorbidities) 2. No correlation given between comorbidities and complications 3. Small group 4. Advise: low risk of AsTs in < 2 years of age
Kalantar, Takehanam Shapiro (2006) (28)	Retrospective case note review	797 53 < 3 yrs age	'Majority of pt <3 yrs between 2.5-3yrs old'	Not reported	Mixed	Haemorrhage < 3 yrs vs > 3 yrs: - primary: 0% vs 0.4% - secondary: 0% vs 0.7%	Minor airway < 3 yrs vs > 3 yrs: 1.8% vs 0.3% No major airway	1. Only ASA-1 and ASA-2 2. Pt < 20 mnts age excluded 3. Discharged after mean of 1.33h of observation
Tweedie et al (2012) (7)	Retrospective case notes and database review	162 7	46 mnts (range 4-197)	Not reported	Mixed (61.4% OSA)	Primary haemorrhage 0.4%	- 1% of admissions unanticipated transfer to PICU - 94.1% of unplanned PICU admission had comorbidities	1. High risk population (75% comorbidities) 2. No significant increased OR for < 2 years vs > 2 years of age

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Theilhaber, Arachchi, Armstrong, Davey, Nixon (2014) (29)	Retrospective chart review	72	2.8 yrs (range 1-13)		OSA		Major airway 8.3% Minor airway 31.9% If uncomplicated PACU stay: 98.3% chance of uncomplicated hospital stay	1. No difference with regards to age, sex, comorbidities, severity of OSA. 2. Small group 3. Only patients admitted to ICU included 4. Mixed population (45.8% significant ant comorbidities)
Bhattacharyya (2010) (30)	Retrospective database review from National Survey of Ambulatory Surgery 2006	480.343 (standard error 90.201)	Not reported	Not reported	Not reported	Haemorrhage 0.0% < 4 yrs vs 0.71% > 4 yrs - 0.3% admitted as inpatient with unexpected admission 9.28% < 4 yrs vs 1.41% > 4 yrs - Revisit surgery centre 2.54% < 4 yrs vs 0.0% > 4 yrs - Visit ED 0.02% < 4 yrs vs 1.47% > 4 yrs	Airway obstruction 0.18% < 4 yrs vs 0.05% > 4 yrs	1. Selection bias: high risk patients not treated in ambulatory setting 2. No intrapatient details available 3. No definition of complications 4. No distinction between < 4 yr vs < 3 yr vs < 2 yr 4. Ambulatory AsTs low risk of immediate postop complications
Spencer and Jones (2012) (31)	Retrospective case note review	86 patients	27.5 mnts (range 13-35 mnts) 76.5% 23-31 months	Not reported	Mixed (96.5% OSA, 2.3% infections) - severe OSA excluded - only ASA I-II	Haemorrhage 0% Dehydration 4.7%	Reactive airway disease 1.2% No postop O_2 requirement	1. No patients with comorbidities or severe OSA 2. Maximum inpatient stay of 6h postop 3. No statistical difference between children <2 or >2 yrs of age

Table 2. Summary of evidence - age less than two possible risk factors

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Hill et al (2011) (32)	Retrospective review, pilot study.	83	4.88 yrs (± 3.09)	54th percentile of BMI (19% obese, 12% FTT)	Severe OSA (AHI > 10 on PSG)	Not reported	Major airway: 4.8% Minor airway: 14.4% Total airway 19% - Patients with risk factors: 38% - Patients without risk factors: 4%	1. Risk factors: - Age < 2 yrs - AHI > 24 - Intra-operative laryngospasm requiring treatment - O2 sats < 90% in PACU - PACU stay > 100 min 2. Pilot study, prospective study to follow 3. Children without risk factors might be treated as day case
McCormick, Sheyn, Haupert, Thomas, Folbe (2011) (33)	Retrospective chart review	993	2.94 yrs 10.3% 1 yr 39.9% 2 yr 49.7% 3 yr	Not reported	Mixed	Primary haemorrhage 0.7% Dehydration 0.5%	Major airway: 1.4% Minor airway: 0.9%	1. Predictors of airway complications - Age <2 yrs - Larger As - Nasal obstruction - CV anomalies 2. Mixed population (41.9% comorbidities)
Horwood, Nguyen, Brown, Paci, Constantin (2013) (34)	Retrospective cohort study	594 pts	4.0 (±2.6)	Weight-for-age *z* score 0.14 (±1.5)	OSA	Not reported	Major airway 12.5% Total airway 29.5%	1. Risk factors: - age < 2 yrs - moderate – severe OSA - comorbidities - low weight-for-age *z* score - African – American race

Table 3. Summary of evidence - Young age with increased risk

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Julien-Marsollier et al. 2018(35)	Retrospective single centre observational study	805 patients 25 study group (respiratory failure) vs 103 control group	2 yrs (range 2-18) vs 6.75 yrs (range 2-18)	13kg (range 8-20) vs 25kg (13-80)	Mixed	Not reported	Major airway 3.1%	1. Weight < 18kg predictor for postoperative respiratory failure 2. Age < 4 years, weight < 18kg, OSAS, laryngomalacia, minor cardiac congenital malformations and duration of anaesthesia associated with major airway event. 3. Limited number in study group 4. No distinction in < 4 yrs vs < 3 yrs vs < 2 yrs
Sanders, King, Mitchell, Kelly (2006) (36)	Retrospective case note review	61 study group vs 21 control group	6.5 yrs (range 2.1-13.3) vs 7.0 yrs (3.4-12.9)	25.9kg (10.3-61) vs 25.5kg (14.7-68.8) BMI 17.2 (11.6-27.8) vs 16.3 (12.6-24.4)	OSAS (study group) vs infection (control group)	Not reported	Young age in OSAS group associated with: supraglottic obstruction on induction, desaturation to < 92% on induction, desaturation to < 92% on maintenance, desaturation to 85% on maintenance	1. Age < 2 yrs and children with comorbidities excluded 2. No quantification of 'young age' and 'low weight' 3. Small groups
Tom et al. (1992) (37)	Retrospective chart review	223	< 3 yrs 9 pts < 1 yrs 78 pts < 2 yrs 136 pts < 3 yrs	Not reported	Mixed (91.5% OSA)	Haemorrhage - primary: 0.0% - secondary: 1.3% Dehydration 1.8%	Major airway 7.6% Minor Airway 52.4%	1. Higher comorbidity rate in ICU pts: 65% vs 14% 2. Old study 3. No age control group 4. Timing of intervention 5. Advise: < 3 yrs need to have inpatient stay
Wiatrak, Myer, Andrews (1991) (38)	Retrospective case note review	200	14 pt < 1 yr 42 pt >1<2 yrs 144 pt >2<3 yrs	Not reported	Mixed	Haemorrhage - primary 0.5% - secondary 1% (all >2<3 yrs) Dehydration 4% (7/8 pt >2<3 yrs)	Total airway 7% (5 pts >2<3 yrs 5 pts <1 <2 yrs) 4 pts <1 yrs)	1. Old study (1985 -1989) '*patients kept intubated for 2 days after postoperative apnoea*' 2. Quality of study 3. Advise: children < 3 years of age should be inpatient

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Hack (2014) (39)	Retrospective case note review	252	3 yrs (range 1-18)	16kg (range 5-127)	OSA	Haemorrhage - primary 0.4% - secondary 1.2%	Major airway 1.6% (3/4 comorbidities) Minor airway 27.4% Higher risk of respiratory complications in high TOME group (total operative morphine equivalent dose)	1. Risk factors: - age - comorbidity - SpO2 low - high ODI4% 2. Age not specified 3. ODI4% not specified
Amoils, Chang, Saynina, Wise, Honkanen (2016) (40)	Retrospective state wide database review	18622 inpatients vs 96592 outpatients	5.4 yrs (range 1-17) vs 7.6 (1-17)	Not reported	Mixed	Not reported	Overall complications 1-12% vs 0.2-5% vs 0-0.38% OR (compared to hernia repair) with 95% CI 3-4 yrs: 4.0 airway (1.8-8.7), 2.2 (1.7-3.0) respiratory, 0.4 (0.2-0.5) cardio 5-9 yrs: 2.6 airway (1.2-5.7), 1.6 (1.2-2.1) respiratory, 0.7 cardio (0.5-1.0)	1. More comorbidities in inpatient setting (65.4% vs 30.6% vs 15.4%) 2. More younger patients in inpatient setting (≤ 2 yrs) 3. Not looked in to correlation between comorbidity and age 4. No report on severity of OSA 5. No distinction in major and minor complications 6. Wide variety in complication rates and wide 95%CI in OR
Smith et al. (2017) (41)	Retrospective database query	630	5.5 yrs (±2.8) 3.7 (±2.3) complications vs 5.9 (±2.9) no complications	BMI for age %: 65.8 (±50.0) 68.9 (±34.2) vs 66.6 (±33.5)	OSA	Not reported	18.4% respiratory complication (O2 sat< 90% or respiratory distress requiring intervention) Major respiratory complication 1.2% (re-intubation, all < 3h postop)	1. Respiratory complications - < 3 yrs (51.7% vs 12.6%) - male sex (63.8% vs 50.4%) - genetic syndromes (31.9% vs 14. 8%) - severe OSA on PSG 2. No impact of race or obesity 3. No distinction between < 3 yrs and < 2 yrs, already existing guidelines followed 4. Variability in admission guidelines and variability in diagnostic accuracy 5. Genetic syndromes included, but no other comorbid conditions reported

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Thongyam et al. (2014) (42)	Prospective observational cohort study	329 89 (27.1%) < 3 yrs	5.3 yr (±3.6)	Not reported 23.7% obese (BMI>95th centile) 12% FTT (weight<5th centile)	OSA	Haemorrhage - primary 0.9% - secondary 5.5% (total group) Dehydration 7.9%	Major airway: 16.7% Minor airway: 10.6%	1. High risk population: - 29% severe comorbidities - 36% asthma - 15.8% ex-prem - severe OSA on PSG 2. Associated with airway events: - age < 3 yrs - severe OSA - FTT - black race 3. No distinction made between < 3 yrs and < 2 yrs
Brigger and Brietzke (2006) (43)	Systematic literature review	16 studies (6698 pts <3 yrs) 4 studies on age effect (454 pts ≤ 3yrs)	≤ 3 yrs (mean not reported)	Not reported	Mixed	Overall complication rate < 24h 12.3% for ≤3 yrs vs 7.9% > 3 yrs	No distinction between surgical and anaesthetic or minor vs major with regards to age	1. Only ASA I-II included, no comment on comorbidities 2. No distinction between >3 and <3>2 yrs 3. Significant heterogeneity between studies ($Q=1.6x10^4$)
Kieran et al. (2013) (44)	Retrospective case note analysis	Study group: 294 (desaturations postop < 90%)) Control group: 368	60.0 (±48.6) vs 82.6 (±50.2)	23.6 (±22.7) vs 28.0 (±18.4) BMI 18.6 (±6.4) vs 17.9 (±4.2)	Mixed	Not reported	Desaturations <24h postop: 7.2% Of desaturation group: 11.2% < 2yrs 37.4% < 3 yrs	1. Timing of desaturation not reported (PACU vs ward) 2. Intervention required not reported 3. Comorbidities 68.37% vs 35.33% 4. Risk factors for desaturation: - Trisomy 21 - OSA - Other syndrome - Cardiac disease - Neurologic disease - Weight < 20kg - Pulmonary disease

Author	Study type	Number of patients	Average age	Average weight	Indication	Surgical complications	Anaesthetic complications	Comments
Leong and Davis (2007) (45)	Literature review	Not reported	Not reported	Not reported	OSA	Not reported	Reported risk factors: - age < 3 yrs - ex-prem - FTT - obesity - asthma - recent RTI - pulse oximetry < 80% - severe OSA - cardiac disease - seizures - craniofacial abnormalities - neuromuscular disorder	
McCarthy Statham, Elluru, Buncher, Kalra (2006) (46)	Retrospective case note analysis	2315 pts 737 pts < 3 yrs 1578 pts 3-5 yrs	Under 3: 2.25 (±0.54) Over 3: 4.36 (±0.85)	Not reported	OSA	Not reported	Total airway 9.8% for < 3 yrs 4.9% for > 3 yrs 'Comparing 2-year-olds with 3-year-olds yielded a significant increase in prevalence in respiratory complications.'	1. Unclear percentages 2. No numbers given on distinction between 2- and 3 yr old 3. Unclear if children with adenoidectomy were included 4. No distinction between major and minor complications based on age 5. No distinction in severity of OSA

Appendix 2.

Evelina Children's Hospital London Data

Adeno-tonsillectomy in young children.
Evelina adeno-tonsillectomy cases aged 0-4
3-year period 2015-2017
Total cases: 1237 (i.e. 55% of all paediatric tonsillectomy cases in this unit 0-16)

Under 1	6
1 year old	105
2 years old	324
3 years old	432
4 years old	370

Day cases	522 (42%)
1 night	596 (48%)
2 nights	63 (5%)
3 nights	12 (1%)
4 nights or more (includes long stay patients)	44 (3.5%)

i.e. 90% discharged within 24 hours of surgery- no peri-op complications

Day cases inner London	359 (52%)
One night stay inner London	262 (38%)
Two night stay inner London	35 (5%)

Day cases outer London	62 (35%)
One night stay outer London	100 (56%) 2 night stay
outer London	8 (4.5%)

Day cases South East	95 (26%)
One night stay South East	217 (61%)
Two night stay South East	18 (5%)

Around 90% of all cases from all addresses are discharged home within 24 hours, but the day case rate falls very significantly with distance from home. The day case rate is double for inner London small children compared with those living outside London

The two-night stay rate is very similar across all areas

Even in this group of small children, the overwhelming majority are discharged without complications within 24 hours. The only factor seemingly affecting day case discharge is distance from home.

Analysis of the cases with prolonged admission (two or more nights): *119 total cases*

None were otherwise straightforward cases (i.e. young/small but otherwise well)
75 significant comorbidities (Down's (9), ex-premature (13), sickle cell (7), cardiac, storage diseases, achondroplasia, craniosynostosis, etc.)
44 no additional co-morbidities, but most with moderate to severe OSA – predictable pre-op as being tertiary cases
7 with sickle cell- all came in night before and stayed for 1night post-op only
6 had discharge delay for pain management

5 under 1 (83% of all under 1s)
23 aged 1 (21%)
30 aged 2 (9%)
36 aged 3 (8%)
25 aged 4 (6.8%)

Other measures

106 HDU beds booked pre-op for aged 4s and under	(8.6%)
9 PICU beds booked pre-op	(0.7%)
One PICU bed unplanned (T21, mod-severe OSA)	
17 revision tonsillectomy cases within this period	(1.4%)

Manchester Children's Hospital Data

3 and Under group 209 patients: Jan 2018-Oct 2018
Average age was 2 years
Average weight 12.5kg

The commonest respiratory complication identified was the need for oxygen supplementation overnight.
For those with no comorbidities it is 0.6%

Looking at complications and focusing on the ones in the comorbidity group versus healthy children, overnight oxygen was only required in those children.
The non-comorbid group contained children with short lasting oxygen needs
One high flow child – developed a postoperative pneumonia
Age without comorbidities and complications, with the exception of one child, the 2-3 year olds had no respiratory problems outside the theatre suite.
Children without comorbidities had minimal respiratory complications above 10 kg

RMCH data 2016 over 5-month period: 194 patients < 16 years
Respiratory complications were 2.8% for all ages and were mainly mild and mainly in the severe OSA group
Respiratory problems predominantly occurred in those with one or more comorbidity.
Non-respiratory complications included two cases of primary haemorrhage.

Leeds Teaching Hospitals 2014/15 data

221 children, 128 had pre-op oximetry, 93 did not.
218 went to the ward, 2 to HDU and 1 to ITU, all planned. No child <2 went to HDU/PICU
Of the 218 who went to the ward, 26 (11.9%) received supplemental O_2.
Many of those needing O_2 had co morbidity.

3/10 or 30% <2years needed O_2
8/36 or 22% 2-3 years needed O_2
9/58 or 16% 3-4 years needed O_2
2/31 or 6% 4-5 years needed O_2

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