AUDIT OF PERI-OPERATIVE PAIN MANAGEMENT IN PAEDIATRIC PATIENTS FOLLOWING TONSILLECTOMY AT A TERTIARY HOSPITAL IN JOHANNESBURG

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A research report submitted to the faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfilment of the requirements for the degree of Master of Science in Medicine in Anaesthesiology

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DECLARATION

I, Palesa Nomusa Mogane, declare that this research report is my work. It is being submitted for the degree of Master of Medicine in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other university.

Signed

On this day of 2017

ABSTRACT

Background

Adeno-tonsillectomy remains one of the most frequently performed surgical procedures in children. Despite improvements in anaesthetic and surgical techniques, severe pain is reported in as many as 25 – 50 % of children. Pain assessment and knowledge of drug pharmacodynamics and pharmacokinetics in the paediatric patient, is a prerequisite for optimal care. Much has been written on peri-operative pain management following tonsillectomy. However, no consensus has been reached on what the ideal analgesic regime should be. This audit is a review of current practice at Chris Hani Baragwanath Academic Hospital. It aims to identify problems and develop possible solutions to improve anaesthetic practice.

Methods

A prospective, contextual, descriptive study design using a data collection sheet was used on paediatrics patients presenting for tonsillectomy.

Results

Eighty five patients aged three to 12 years of age, with ASA grading I or II were enrolled in the study. The choice of anaesthetic was variable with a combination of simple analgesics, opioids and adjuvants. This affected postoperative pain scores. Snare dissection and monopolar cautery haemostasis, was the standard surgical technique. Surgical seniority influenced the duration of tonsillectomy, with an effect on postoperative pain scores.

Conclusions

Audits are necessary to evaluate what resources are needed to optimise care. The occurrence of pain after tonsillectomy continues to be poorly managed. Appropriate premedication and no more than two hours of starvation (after clear liquid ingestion) needs to be introduced. Where possible surgical technique should involve bipolar cautery and be limited to less than 45 minutes. A preemptive, multimodal, opioid-sparing anaesthetic should be routinely practiced.

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NSAIDs – non-steroidal anti-inflammatory drugs

Ig – immunoglobulin

SDB – sleep disordered breathing

OSA – obstructive sleep apnoea

PTH – post tonsillectomy haemorrhage

USA – United States of America

NMDA – N-methyl-D-aspartate

GABA – gamma-aminobutyric acid

DVT – deep venous thrombosis

ED – emergence delirium

PONV – postoperative nausea and vomiting

LMA – laryngeal mask airway

DVT – deep venous thrombosis

FLACC – Face Legs Activity Cry Consolability

CHEOPS – Children's Hospital of Eastern Ontario Pain Scale

NRS – Numerical Rating Scale

VAS – Visual Analogue Scale

FPS-R- Faces Pain Scale – Revised

WHO – World Health Organisation

PCA – patient controlled analgesia

COX – cyclooxygenase

PACU – post anaesthesia care unit

FDA – Food and Drug Administration

EMA – European Medicines Agency

URTI – upper respiratory tract infection

AHI – apnoea-hypopnea index

e-PONB – early postoperative negative behaviour

ETT – endotracheal tube

TIVA – Total Intra-Venous Anaesthesia

PRN – pro re nata

PMO – Principal Medical Officer

ASA – American Society of Anaesthetists

PAED – Paediatric Anaesthesia Emergence Delirium

CHBAH – Chris Hani Baragwanath Academic Hospital

ENT – Ear Nose and Throat

SECTION 1: Literature review

1.1 Introduction

Adeno-tonsillectomy is one of the commonest performed surgical procedures in the paediatric population (1) with an estimated 200 000 performed in the United Kingdom annually and more than 500 000 – 737 000 in the United States (2, 3). Unfortunately, little data exists for South Africa. Mortality, although rare, has been estimated to be between 1 in 16 000 to 1 in 35 000 and is usually attributed to bleeding, aspiration, cardiopulmonary failure, electrolyte imbalance, or anaesthetic complications (4).

Severe pain, postoperative vomiting and emergence delirium still continue to be common complications. This is despite improvements in anaesthetic and surgical technique. In fact, severe pain is reported in as much as 25 – 50 % of children presenting for tonsillectomy, with or without adenoidectomy (5). Optimal pain management requires initial pain assessment. After pain has been adequately assessment, an appropriate intervention can be instituted and the effectiveness thereof ensured. Various tools exist. Most are not universally accepted or well validated, and cannot be applied to all age groups.(6)

The management of pain has traditionally been controlled with a combination of paracetamol, non-steroidal anti-inflammatory drugs (NSAIDs) and opioids. Paracetamol is a safe and effective analgesic, but is often insufficient on its own. Concerns with NSAIDs are that they may be inclined to increase the occurrence of postoperative bleeding. Opioids on the other hand, result in a high incidence of post-operative nausea and vomiting, respiratory depression, and also sedation. This may present a perilous situation after pharyngeal surgery, where a rapid return of airway reflexes is desired (5). In this regard, more research is required to determine optimal analgesic treatment of tonsillectomy pain. The aim of this study is thus to review current literature regarding the pathogenesis of tonsillectomy pain, pain assessment tools, peri-operative tonsillectomy pain management, and controversies that exist in this field.

1.2 Anatomy and immune function of tonsils and adenoids

1.2.1 Anatomy

There are four different types of tonsils: pharyngeal, palatine, lingual and tubal. Together they form what is called Waldeyer's ring. The figure below illustrates this (Figure 1). This is lymphatic tissue placed in strategic areas of the throat. It constitutes the first line of defence against ingested and inhaled pathogens. The palatine tonsils are found where the oral cavity and the oropharynx join. This tonsillar fossa is composed of three muscles: the palatoglossus which forms the anterior tonsillar pillar; the palatopharyngeus, which is the posterior tonsillar pillar; and the superior constrictor muscle of the pharynx, which forms the tonsillar bed.

The tonsil lies between the palatoglossus and palate pharyngeal muscles. It is innervated by the tonsillar branches of the glossopharyngeal nerve and branches of the lesser palatine nerves. The blood supply to the tonsil is via dorsal lingual artery and facial artery at the lower pole, and the ascending pharyngeal artery and the lesser palatine artery supply the tonsil via its upper pole (7). Venous drainage occurs via the internal jugular vein.

The palatine tonsil differs from the lingual and nasopharyngeal tonsils (adenoids) in that it has a thin capsule on the deep surface. This capsule is a portion of the pharyngo-basilar fascia and extends into the tonsil to form septa that conduct nerves, blood vessels, and lymphatic tissue. The surface of the tonsil is lined by stratified squamous epithelium, which extends deep into the tissue forming the tonsillar crypts. These crypts help to increase surface area and trap germs.(7)

The nasopharyngeal tonsils (adenoids) are located with the apex pointing toward the nasal septum, and the base toward the roof and the posterior wall of the nasopharynx. They begin shrinking at age seven to eight, and disappear by adulthood. Adenoid tissue is lined by respiratory epithelium; its exposed surface is covered by stratified and pseudostratified ciliated columnar epithelium.(4) There is

no capsule surrounding the adenoids. This is postulated to be one of the reasons why an adenoidectomy is less painful than a tonsillectomy.

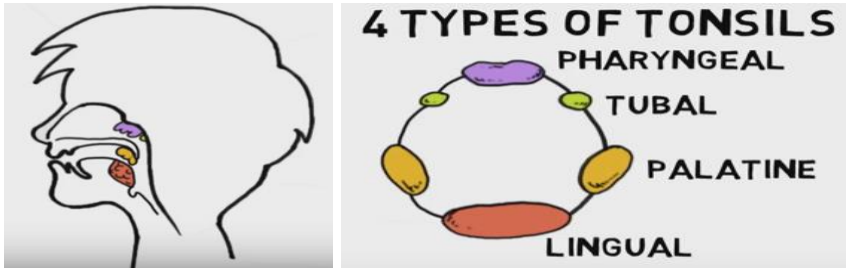

Figure 1.1 Anatomy of tonsils (8)

1.2.2 Immune function of tonsils and adenoids

Antigens entering through the nose and mouth initiate an immune reaction. These antigens are taken up into vesicles and transported to the extra follicular region or the lymphoid follicles. They are processed and then presented to helper T lymphocytes. This prompts the growth and development of follicular B lymphocytes into either B memory cells, that are able to relocate to the nasopharynx, or plasma cells that are able to produce and release antibodies into the lumen of the crypt.(9)

Inevitably, both the adenoids and tonsils will contain predominantly B-cell lymphocytes (50-60%); they also contain T cell lymphocytes (40%) and mature plasma cells (3%) (4). Secretory IgA, produced in the palatine tonsils, is an important part of the upper airway's mucosal immune system. This is coupled to a J (joining) chain carbohydrate and assists in B cell activity. (10) This allows the tonsils and adenoids to induce immunity and regulate immunological production

Chronic or recurrent tonsillitis results in a large number of antigens with an increase in mature B-cell clones and fewer early memory B cells which would have gone on to become J-chain-positive IgA immunocytes. The antigenic stimulation can also overwhelm the tonsillar lymphocytes to the extent that they are unable to respond to any other antigens (9, 10). The role of the tonsil in local protection is now impaired. It can no longer reinforce the secretory immune system, and there would thus be therapeutic advantage to its removal.

There are conflicting studies regarding the effects of adeno-tonsillectomy on immunity. Some studies demonstrate a three to four fold decrease in IgA concentrations in the serum and adjacent tissues as well as a delay and lower nasopharyngeal secretory immune response (10, 11). Another study has shown better neutrophil chemotaxis after tonsillectomy, and another demonstrated increased IgG and IgM production (7). However, no studies to date have shown a significant clinical impact of tonsillectomy on the immune system.

1.3 Indications for surgery

The immunological activity of the tonsil is at its peak between the ages of three and 10 years (4). This coincides with the bimodal age distribution of tonsillectomy, with the first peak between the ages five and eight years, and the second peak between the ages 17 and 21 years (12). When appropriately indicated, the benefits of a tonsillectomy are: decrease in recurrent pharyngitis and upper airway resistance; relief or cure of obstructive sleep apnoea and sleep disordered breathing; and improvement in child health status and the quality of life (13). What constitutes the correct indication for surgery is debateable. The potential benefits must be weighed against the substantial risks. The two most common indications for tonsillectomy are recurrent throat infections and chronic adeno-tonsillar hypertrophy associated with airway obstruction and sleep disordered breathing (SDB).

Some uncertainty exists whether observation with medical therapy is more beneficial than an actual tonsillectomy, especially when the cause is pharyngitis. However, multiple randomized controlled trials have shown that tonsillectomy in children with severe recurrent infections, resulted in a decrease in severity and frequency of infection two years post-surgery. These advantages were not found in less severe tonsillitis.(14) Validated instruments used in observational studies have also shown an improvement in the quality of life when tonsillectomy was performed for recurrent or chronic pharyngitis (15).

Evidence in the form of a meta-analysis and recent studies (9) has shown that tonsillectomy is effective at improving or resolving SDB in most children. There is also belief that behavioural patterns, school performance and quality of life is improved. Interestingly, data from the National Hospital Discharge Survey in the USA from 1978 to 1986 has shown that throat infection as an indication for surgery has declined, and SDB as the primary indication has significantly grown in the last 35 years. (9)

1.3.1 Sleep disordered breathing

The term sleep disordered breathing, includes a group of disorders ranging in severity from primary snoring to obstructive sleep apnoea (OSA). The occurrence of OSA in the American paediatric population is 1 – 4 %, with as many as 10 % of children having primary snoring. Up to 30 - 40 % of children clinically diagnosed with SDB exhibit behavioural problems such as irritability, enuresis, hyperactivity, aggression, anxiety, depression and somatisation (9). Obstructive sleep apnoea (OSA) is also associated with poor performance at school, because of daytime somnolence and problems with memory and attention. There is also the opinion that there is a decrease in the quality of life similar to that of children with chronic conditions, such as asthma and juvenile rheumatoid arthritis (9). There are several grading systems for assessing tonsillar size; the most commonly used being described by Brodsky (Table 1.1).

The Brodsky grading scale from 0 to 4 is based on the percentage of oropharyngeal airway occupied by the tonsils (4). The oropharyngeal airway is designated by the linear distance between the two anterior tonsillar pillars. Tonsillar hypertrophy is defined as 3+ or 4+ (4) and it is important to note that tonsils do not need to be kissing to be graded as grade 4+. Tonsillar size alone doesn’t correlate with the severity of SDB. The combined volume of the adenoids and tonsils more closely correlate with the severity of SDB (9). This grading system is easy to understand and follow, but many studies have shown that the volume of the adenoids and tonsils relative to the oropharynx is a better determinant of the severity of SDB/OSA. (9)

Table 1.1 The Brodsky grading scale for tonsillar enlargement (9)

Grade	Definition	Description
0	Not visible	Tonsils within the tonsillar fossa, doesn't reach the tonsillar pillars
1	Less than 25 %	Tonsils just outside the tonsillar fossa and occupies less than 25 % of the oropharyngeal width
2	25 to 49 %	Tonsils fills less than 50 % of the oropharyngeal width
3	50 to 74 %	Tonsils occupies 50 to 74 % of the oropharyngeal width
4	75 % or greater	Tonsils fills more than 75 % of the oropharyngeal width

1.3.2 Recurrent tonsillitis

Viral infections are the most common cause of acute tonsillitis / pharyngitis; adenovirus being the most common cause of non-streptococcal tonsillitis. Group A β-haemolytic streptococcus is the most common bacterial cause of acute pharyngitis. The peak incidence occurring in children five to six years of age during winter and spring (4). In 2011 the American Academy of Otolaryngology – Head and Neck Surgery Foundation released the "Clinical Practice Guidelines : Tonsillectomy in Children" (9). These guidelines were intended to minimise harm by reducing inappropriate variations in clinical care and producing optimal health outcomes for patients. However, at no point are they intended to supersede professional judgement.

The comprehensive guidelines recommend watchful waiting for a 12 month period for recurrent throat infections in children not meeting the Paradise criteria (Table 1.2). However, exceptions exist to these criteria, whereby adeno-tonsillectomy can take place prior to the end of the 12 month observation period even if they do not meet the frequency criteria. These are patients presenting with a history of recurrent severe infections requiring hospitalisation, or those who have sequelae such as peritonsillar abscess or Lemieree syndrome (9). Patients who truly benefit from tonsillectomy are those with proper documentation of the severity and frequency of these attacks. Poorly validated indications for tonsillectomy include halitosis, dysphagia, muffled speech, febrile seizures and malocclusion. (9)

Table 1.2 Paradise criteria for tonsillectomy (9)

Criterion	Definition
Minimum frequency of sore throat episodes	7 or more episodes in the preceding year, OR 5 or more episodes in each of the preceding 2 years, OR 3 or more episodes in each of the preceding 3y
Clinical features (sore throat plus the presence of one or more qualifies as a counting episode)	Temperature > 38.3 ˚ C, OR Cervical lymphadenopathy (tender lymph nodes or > 2 cm), OR Tonsillar exudate, OR Positive culture for Group A β-haemolytic streptococcus
Treatment	Antibiotics had been administered in conventional dosage for proved or suspected streptococcal episodes
Documentation	Each episode and its qualifying features had been substantiated by contemporaneous notation in a clinical record, OR If not fully documented, subsequent observance by the clinician of 2 episodes of throat infection with patterns of frequency and clinical features consistent with the initial history

Some studies have shown that children presenting for tonsillectomy due to SDB experienced less pain postoperatively than those presenting due to infective causes.

1.4 Pathogenesis of tonsillectomy pain

1.4.1 Physiology

The International Association for the Study of Pain defines pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage” (16). This recognises that the nature of the pain experience has physiological and affective components. It is a complicated process that has been difficult to assess and manage in the paediatric population. Acute pain is defined as a “short, limited yet normal predicted response to an adverse chemical, thermal or mechanical stimulus ” (17). A cause such as trauma, surgery, tissue damage or an inflammatory process is usually identifiable. Nociceptive and neuropathic pain are the two major classes of pain.

Nociceptive pain is the normal neural processing of pain which takes place when free nerve endings are stimulated by tissue damage or inflammation. It involves the processes of transduction, transmission, perception and modulation. (18) A knowledge of these processes assists in understanding pain mechanisms and instituting appropriate interventions.

Firstly, prostaglandins, bradykinin, serotonin, noradrenalin, leukotrienes, nerve growth factors, substance P and histamine are released with tissue damage (18, 19). An interaction of these substances with nociceptors results in the production of an action potential (**transduction**) which moves from the site of injury to pain receptors in the spinal cord (**transmission**). Release of excitatory neurotransmitters: substance P, neurokinin 1 and glutamate (which eventually sensitises and activates the high threshold NMDA receptor), and inhibitory neurotransmitters : noradrenaline, dopamine, serotonin, histamine, oxytocin and vasopressin, acetyl choline, GABA, glycine and opioids; carry the action potential to the dorsal horn of the spinal cord.

From here it ascends via the spinothalamic tracts, thalamus and midbrain to send the “pain message” to higher centres (somatosensory cortex, parietal lobe, frontal lobe and the limbic system) where **perception** can take place. Activation of the midbrain results in **modulation**. Efferent pathways result in the release of multiple neurotransmitters and endogenous opioids, resulting in inhibition of further transmission of the pain impulse. Modulation of this process can occur by decreasing excitation (opioid receptor, sodium channel blockers, ketamine) and / or increasing inhibition (alpha-2-agonism, glycine / GABA agonism) at the level of the spinal cord. An appreciation of the complexities involved in nociception promotes the development and usage of various pharmaceuticals and interventions to limit the consequences of pain.(18, 19)

1.4.2 Contributing factors to pain

- **Patient**

A systematic review was published in 2016, titled “The predisposing, precipitating, perpetuating and present factors predicting anticipatory distress to painful medical procedures in children" (20). A high positive relationship between anticipatory anxiety and levels of postoperative pain was found. A summary of the findings follows (Figure 1.2).

Predisposing factors (intrinsic factors) such as temperament, gender and age; as well as socio-economic circumstances, were examined. The contribution of age was unclear, but there was a suggestion that younger children have higher anticipatory distress. Gender seemed to have no effect on anticipatory distress, but six studies found that girls experienced more distress than boys (closer to the pubertal age). Birth order and number of siblings had no effect, while child illness, intelligence and previous interaction with the health system were found to positively predict anticipatory distress. Literature also supported the fact that psychopathology and temperament influenced their experience of pain. Parent anxious predisposition and pain experience were also associated with increased anticipatory distress.

Precipitating factors such as previous pain were seen as factors that contributed to anticipatory distress.

Perpetuating factors were those seen to maintain the perception of the problem such as child knowledge, coping style, cognition (fear of impending threat, decreased control of the situation and hostility towards performing the procedure) or parent behaviour. The role of these was assessed as inconclusive.

Present factors which took place at the same time as the procedure could positively or negatively impact on the distress. Idiosyncratic needs such as fatigue, hunger, dehydration and nausea were positively associated with child anticipatory distress.

The contribution of parental presence to anticipatory distress was inconclusive in this review. However, other research has shown this to positively impact on the reduction of patient distress and thus experience of pain. Health professional behaviour is speculated to play a significant influence on how children and families experience painful medical procedures (20). This review has highlighted risk factors that can be screened for, prior to surgery, so as to have a better understanding on how a child will cope or respond to the procedure, and possibly gives us ideas on how to pre-emptively optimise our management.

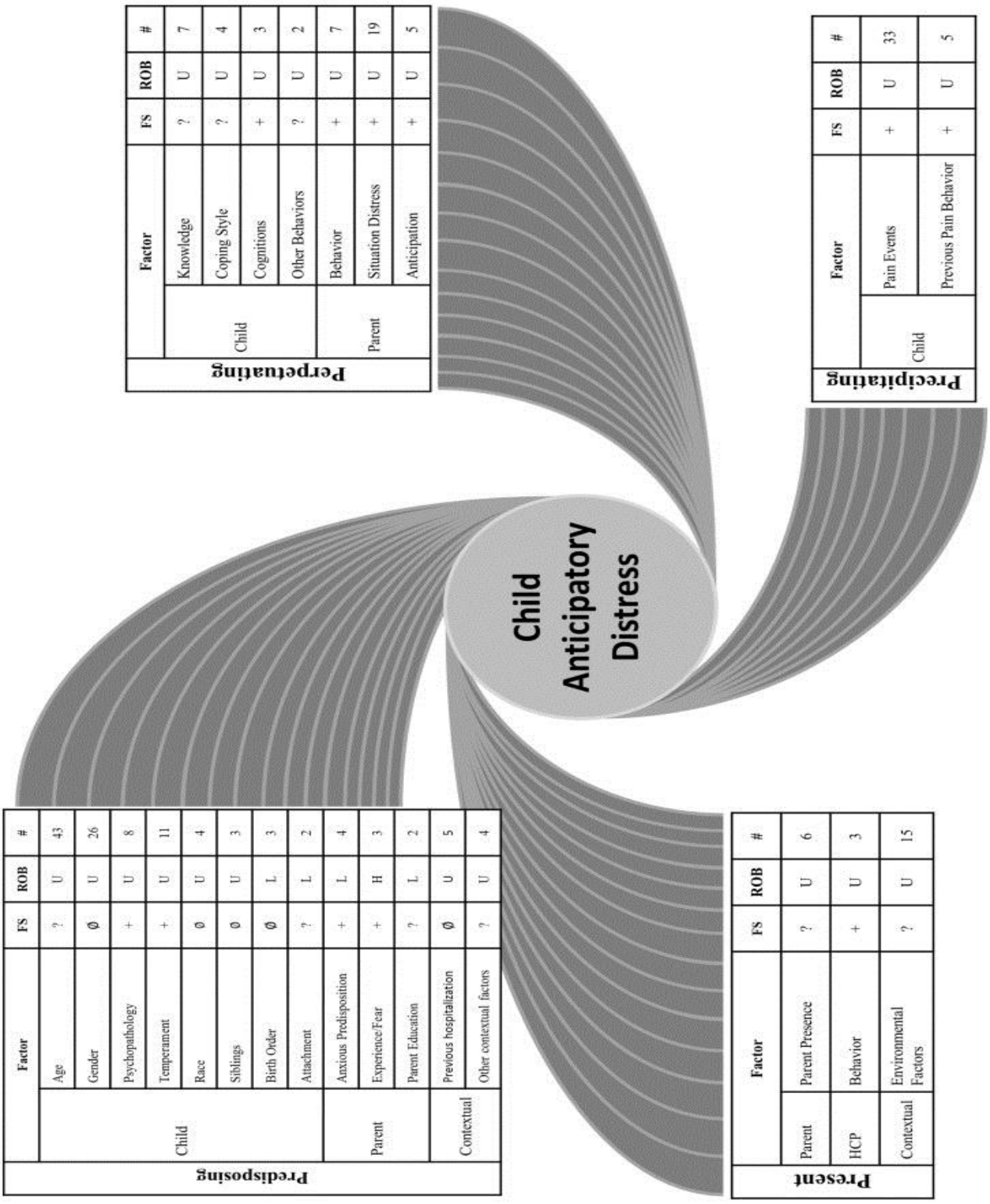

Figure 1.2 Summary figure of results (20)

FS=findings synthesis, ROB=risk of bias, +=factor has a positive relationship with anticipatory distress, ø=no effect or significant relationship, ?=inconclusive results, U=unclear risk of bias, L=low risk of bias, H=high risk of bias, #=number

- **Surgical factors**

Tonsillectomy involves the complete removal of the tonsil and capsule from the muscular wall. This is a different to a tonsillotomy (subtotal removal of the tonsil without violating the capsule) and adenoidectomy which are less painful due to the lack of capsule involvement (13). Various surgical techniques exist, the choice of which will be based on surgeon preference, experience and instrumentation availability.

Cold dissection (scalpel, guillotine and snare) has been traditionally used. Metal instruments are used, and haemostasis is achieved by ligature of the blood vessels (4). This has been shown to decrease the development of secondary haemorrhage, but increases the length of surgery. Decreased intraoperative thermal damage is associated with better cutaneous healing time, wound bed strength, and thus less pain.

Hot dissection (monopolar or bipolar electrocautery) is one of the most common techniques. Temperatures of 400 ˚C to 600 ˚C are used to separate the tonsil from the underlying muscle. It coagulates blood vessels and achieves haemostasis during dissection. Electrocautery reduces intraoperative blood loss and the risk of primary haemorrhage and has the added advantage of reducing operating time. However, monopolar electrocautery is associated with an increased risk of secondary haemorrhage, slower healing and greater postoperative pain when compared with cold dissection. This may limit its use.(21) Bipolar cautery is preferred as it is known to cause less tissue damage and therefore less postoperative pain when compared to monopolar electrocautery (7). It was actually found that post tonsillectomy pain using bipolar cautery and cold dissection is comparable and is similar (21).

Coblation uses bipolar radiofrequency energy. The device works at lower temperatures of 40 ˚C to 70 ˚C compared to electrocautery. Some studies suggest that the lower temperatures generated in coblation result in reduced thermal damage to surrounding tissue, which in turn results in less postoperative pain.(21)

Other studies report there is less postoperative pain with coblation rather than electrocautery only on the day of surgery (4). There is also less risk of fire related injuries.

The microdebrider can be used for intracapsular tonsillectomies. It removes 90 % of the tonsillar tissue whilst maintaining the integrity of the tonsillar capsule i.e. less pain. However, it has not been commonly used because of the possibility of tonsillar regrowth leading to reoccurrence of SDB/OSA and tonsillitis. This technique is associated with decrease morbidity, but greater intraoperative blood loss when compared to electrocautery tonsillectomies.(4)

Evidence remains inconclusive regarding the difference of perioperative pain and the varying degree of surgical experience. Post tonsillectomy haemorrhage (PTH) and surgical experience has been examined and it was found that the duration of surgery and the likelihood of PTH was greater in procedures performed by a beginner (≤ 5 years) versus those performed by an experienced surgeon (≥ 6 years)(22). Most of the complications of paediatric tonsillectomy come from the injury of surgery (whether by cold or hot techniques) and the inflammatory process of second intention healing resulting from the open pharyngeal wound.

Oral mucosal healing proceeds through the same process seen in skin. This includes haemostasis, inflammation, proliferation and remodelling of the collagen matrix. Inflammation and fibrin clot accumulation is at its best on days 3 through to 7, resolving by day 14 when the tonsillar fossa is fully healed (2, 4, 13). This coincides with pain being most intense in the first 3 days. This is followed by a gradual reduction over the next 4 days. The change in the downward trend of pain coincides with the onset of ear and jaw pain. This usually resolves by day 14 post surgery (23-25).

- **Anaesthetic factors**

It is difficult to isolate anaesthetic factors that contribute to perioperative pain in adeno-tonsillectomy patients. Rather a look at significant variations in technique will be discussed. The usage of suitable premedication has been found to decrease anticipatory anxiety associated with surgery, and potentially contribute to the incidence of early postoperative negative behaviour i.e. emergence delirium and pain (26, 27).

Children who present for adeno-tonsillectomy have a high incidence of airway reactivity and laryngospasm. This influences the choice of airway management. The use of cuffed tubes has become common practice, but the reinforced laryngeal mask airway is an alternative especially if trying to avoid the intubation / extubation response, post extubation stridor and laryngospasm in the highly reactive airway (28), and emergence delirium (67). Issues of cost, adequate protection of the airway from contamination, and surgical access have affected the popularity of LMA use.

Historically, muscle relaxants have been used for intubation in tonsillectomy, but with time, deepening with volatiles and topicalising the oropharyngeal area with local anaesthetic have become common practice. The advantage is the avoidance of reversal agents (which may contribute to the incidence of PONV) and a faster return of airway reflexes. The usage of muscle relaxants and sedatives increases the risk of respiratory depression. Whether this contributes to orolgia cannot be definitively concluded. (28)

Studies that have examined ‘awake vs deep extubation’ are somewhat dated (29). Awake extubation takes place when there has been a return of laryngeal reflexes and the patient can protect their airway from aspiration. However, this may be associated with the potential risk of haemorrhage, wound dehiscence and desaturation. Deep extubation is associated with minimal irritation to the trachea and pharynx, thus reducing coughing and postoperative bleeding, and allowing the child to wake up peacefully and potentially reducing the occurrence of ED.

The fundamental disadvantage is the unprotected airway with the potential of aspiration. A study by Baijal et al (29) in 2014 looking at major and minor respiratory complications after tonsillectomy, revealed no differences whether children were extubated awake or deep. This may simply be because selected extubation technique was based on the clinical judgement, expertise and comfort of the attending anaesthesiologist (29).

1.4.3 Consequences of pain

Pain intensity varies with the site of the surgery, type of surgery, time of day, age, cultural background and physiological makeup of the child. Acute pain causes a change in the physiology of multiple organ systems. The induced stress state has neurohumoral changes with multiple implications (Table 1.3). Poorly controlled pain can also increase morbidity such as vomiting with poor oral intake, disturbances in sleep and changes in behaviour. This results in prolonged hospitalisation, and may thus have an impact on economic constraints and overall patient, parent and nursing staff satisfaction. Adequate pain management minimises this multi-system response.

Table 1.3 Adverse effects of pain (30, 31)

System	**Physiological effect of pain**
Neurological	Change in sleep pattern, anxiety, depression, development of chronic pain
Cardiac	Tachycardia, elevation in blood pressure, increase in cardiac workload & oxygen consumption
Respiratory	Retention of secretions and reluctance to cough, atelectasis, pneumonia
Gastrointestinal	Poor feeding, dehydration, ileus, nausea & vomiting
Renal	Retention of sodium and water, potassium loss, urinary retention
Coagulation	Hypercoagulable with reduction in fibrinolysis
Immune	Poor wound healing and increased risk of infection
Metabolic	Increased metabolic rate, sweating, increased fluid and electrolyte losses
Endocrine	Increase in stress hormones resulting in increased load on renal and cardiovascular systems, increase in glucose and cortisol levels
Musculoskeletal	Reflex muscle spasm at site of tissue damage, immobility, venous stasis, coagulability and risk of DVT

1.5 Complications of tonsillectomy

Although adeno-tonsillectomy is a relatively safe procedure, complications can occur, and this has to be taken into account when making the decision to proceed with a tonsillectomy. Postoperative complaints include odynophagia, nausea, vomiting, referred otalgia, emergence delirium, haemorrhage, fever and dehydration. Oropharyngeal pain is significant and near universal regardless of the surgical technique. It can lead to poor oral intake and dehydration, necessitating delayed discharge from the hospital or readmission for pain control and intravenous fluid. Post tonsillectomy haemorrhage (PTH) rates range from 0.5 % to 10 %. This phenomenon can be categorised into primary and secondary haemorrhage.

Primary haemorrhage occurs within 24 hours of surgery, while secondary haemorrhage presents after 24 hours, most commonly on postoperative day 5 to 10 (32). Primary bleeding (incidence rate of 0.2 – 2.2 %) is generally considered to be related to surgical technique and is thought to be more dangerous because of the risk of laryngospasm, nausea and vomiting and aspiration (33). Secondary bleeding (incidence rate 0.1 – 3 %) is usually caused by the shedding of the eschar as the tonsil bed heals (9). Factors that contribute to bleeding include 'hot surgical techniques', medications that the patient is prescribed e.g. non-steroidal anti-inflammatories, patient age (the older the patient, the greater the risk of bleeding), male gender, and those with a history of recurrent acute tonsillitis and previous peritonsillar abscess (34). Interestingly more secondary bleeding and pain was found in infective causes of tonsillitis rather than obstructive.

Trauma and oedema of the tongue, nasopharynx, and palate can cause upper airway obstruction. This coupled with the risk of OSA and upper respiratory tract infections in this population of children, increases the potential of airway compromise. Laryngospasm, bronchospasm and desaturation are but a few airway risks that have to be anticipated. Nasopharyngeal stenosis, velopharyngeal insufficiency and psychological trauma are rare but potential complications (4). Mortality from tonsillectomy is attributed to bleeding, aspiration, cardiopulmonary failure, electrolyte imbalance or anaesthetic complications (35).

Litigation relevant to the anaesthetist has involved airway compromise resulting in anoxia and impaired function, poor or inappropriate informed consent and medication related errors (35). Opioid therapy has been noted as the third most frequent cause for fatal injuries post tonsillectomy (35). This will be further explored when we discuss the pharmacology of pain.

1.6 Assessment of pain

Optimal pain management can only occur if pain has been appropriately assessed. Thereafter adequate interventions are instituted, and the necessary steps taken to ensure their effectiveness. Due to the multifactorial facets of pain, a systematic approach is advised. One such approach is called “QUESTT: Question the child; Use the age and developmentally appropriate pain rating scales, Evaluate behaviour and physiological changes, Secure parental involvement, Take the cause of pain into account ; and Take action and evaluate results” (30).

A key point to be noted when using QUESTT is that ideally the child should be questioned prior to the painful stimulus. This establishes the child’s previous pain experiences, their expectations, and even their preconceived perceptions about pain. This is ideally applied in children of the appropriate age and developmental stage, who are undergoing elective procedures. Furthermore, it allows familiarisation with specific words and behaviour that should be attributed to the pain. Family participation is of the utmost importance. This allows them to understand changes that may occur in the child’s behaviour, as well as knowledge of how stressful the process may be.

Many tools are available for the assessment of pain in children of variable ages, in different stages of development, and under a variety of clinical circumstances. The selection of the tool can be guided by age, the clinical setting in which it has been validated, by the ability to use it in multicultural and multilingual population; also whether the tool is supposed to be used by the patient, parent or medical practitioner; and resources and training required to deliver the tool (36).

Most of these tools are not universally accepted, validated or applicable to all age groups. In general, there are physiological measures, behavioural (observational) measures and self-report (6, 30, 36). Additional factors need to be considered to help guide choice of scale in different clinical situations e.g. children who non-verbal or who have cognitive impairment.

Tools that require an observer to rate them, may enhance a self-report. This is particularly useful when children are unable or unwilling to report their pain. Trans-lingual and trans-cultural validity is unclear with most tools. However, there are some exceptions where robust translation of tools has been validated in languages other than English. Little literature exists on the validity and appropriateness of existing pain scales in non-English speaking South African children.

1.6.1 Physiological

Pain in children can be assessed via physiological parameters. These include changes in heart rate, blood pressure, intracranial pressure, cerebral blood flow, palmar sweating, respiratory rate; and also a decrease oxygen saturation and vagal tone (6). They serve as useful surrogate measures of pain, but there is limited clinical utility (37). Furthermore, the sensitivity and specificity of these measures can be skewed by the existence of other clinical conditions. Sepsis, anxiety, hypoxemia, hypotension and fever, present with the same features but are unrelated to pain. Therefore other tools must be used in conjunction with physiological measures (37) i.e. multidimensional pain assessment.

1.6.2 Behavioural

There are a series of behavioural responses seen in children that occur due to pain. These include crying, grimacing, movement of the trunk and limbs, consolability and changes in sleep state. These can be a substitute measure of pain. However, once again, the sensitivity and specificity is poor as other conditions can cause these features.

An observational measure should be used with self-report in children three to five years of age as the reliability and validity of self-report measures of pain intensity in this age group is limited (36, 37). Behavioural scales that exist and can be used in preverbal and non-verbal children are tabulated below (Table 1.4).

Table 1.4 Behavioural / composite pain assessment tools for preschool children (6)

SCALE	AGE GROUP	INDICATORS	SCORE	COMMENTS	TIME FOR ASSESSMENT
COMFORT scale	0 – 3 years.	6 behavioural items (alertness, calmness, muscle tone, movement, facial tension, crying) 2 physiological items (heart rate and mean arterial pressure)	Ranges from 8 – 40	Assesses distress in ICU children up to 2 yrs. and post-operative pain up to 3 yrs.	2 minutes
Children's Hospital of Eastern Ontario pain scale (CHEOPS scale)	1 – 7 years	6 pain behaviour items (cry, facial and verbal expression, torso position, touch, leg position)	Total score ranges from 4 – 13 (cut-off point of 6 yields highest agreement with clinical decision to treat pain)	High correlation with observer and nurses VAS scores. Excellent reliability and acceptable validity	Child's response is observed for 5 seconds, followed by 25 seconds period of recording
Face, Legs, Activity, Consolability scale (FLACC scale)	2/12 – 7 years	Five categories (facial expression, leg movement, activity, cry, consolability)	Ranges from 0 – 10. Score ≥ 3 represents pain	Moderate to good concurrent validity with OPS and CHEOPs.	Patient's behaviour observed for 1 – 5 min and score assigned
Ontario Pain Scale (OPS scale)	18/12 – 12 years	6 items (blood pressure, crying, movement, agitation, posture, complains of pain where appropriate)		Modified OPS has shown excellent reliability, construct, content & validity	30 – 60 seconds

A wealth of knowledge can be attained from using behavioural observation and should be part of pain assessment in children of all ages and neurological ability. Many of the mentioned observational scales incorporate both physiological and behavioural items e.g. the FLACC, CHEOPS and COMFORT scales, which makes them more comprehensive. In some literature they form a separate group of pain assessment tools known as Composite measures / scales (6). No scale has been found to be superior or used universally.

1.6.3 Self report

Self-report, which is often possible in children of four years of age and above, is often seen as the 'gold standard' of assessment as it is a direct, verbal measure of pain (37). There are multiple tools available for use (Table 1.5). The tool used must be practical for use in the specific clinical setting; it should be reproducible, reliable, valid; transferable between assessors; appropriate to the child's age and developmental level; and chosen in collaboration with both the child and caregiver. If the FACES pain assessment tool (e.g. Wong Baker FACES Figure 1.3) is being used, then the representation of each face must be explained. The child should be able to assign a face or number that they best associate with the way they are feeling at the time of testing.

When using a numerical scale, one must appreciate that this is usually only reliable in children of school going age i.e. a chronological age of eight years, when there is knowledge of numerical order and value. (30) Furthermore, one must elicit the typical characteristics of the pain such as factors that alleviate or aggravate the pain, its location and radiation. Controversy exists on whether or not self-report scales can be classified as truly evidence-based. The opinion exists that pain is so complex and multidimensional, that intensity scales are an oversimplification. However, these tools are all we have available, and many studies (30, 37) have proven that their use in clinical paediatric practice should be continued.

Table 1.5 Characteristics of frequently used self-reporting pain assessment tools (30)

Scale	Components	Age range (yr.)	Pros	Cons	Comments
Wong Baker FACES	Six faces (0-10), Value 0-10	3 – 18	Easy, quick	Confusion with happiness	Requires paper scale
FACES pain scale revised (FPS-R)	Six mature faces (0-5), value 0 -10	4 – 12	Easy, quick	Confusion with happiness	Requires paper scale
Pieces of hurt	Five stones or poker chips	3 – 8	Simple	Time consuming	Requires pieces
Numerical analogue (NRS)	Verbal scale 0-5 or 0-10	8 – 18	Easy, quick	Requires numeracy	No props required
Visual analogue Scale (VAS)	10 cm line, scale 0-5 or 0-10	8 – 18	Easy, quick, versatile	Requires proportionality	Requires pen and paper
Adolescent paediatric pain tool	Body map drawing and word graphic scale	8 – 18	Detailed	Time consuming	Requires pen and paper

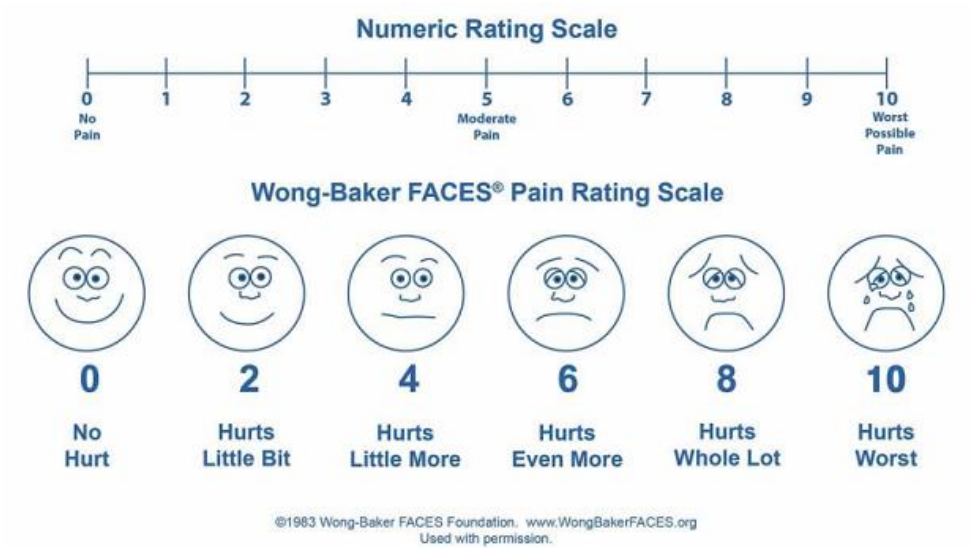

Figure 1.3 Wong Baker FACES scale (38)

Response bias is the inclination to respond systematically to questioning in ways that are not related to the item content. This can occur in self-report, and often reflects the child's interpretation of the pain assessment. Although children are often asked to describe their internal states e.g. hunger or tiredness, rarely do they need to quantify these states. Self-report is thus an unusual practice for the child. (37) Response biases that exist include: anchor effects (estimation of pain influenced by prior experience or surroundings); sequence bias (e.g. child's initial answer is left most face, subsequent answer is to the face adjacent resulting in a score in ascending or descending order); and repetition of the same answer to all questioning (37).

It should be noted that inaccurate responses do not always mean the existence of responsive bias. These can occur due to a lack of understanding in children with pre-existing learning or cognitive difficulties, deliberate random or incorrect responses, or even the lack of motivation and attention to the task (37). This can often occur when pain is measured at a single time period. For this reason it is advised that findings from self-report scales be corroborated with observational measures in children younger than five years of age. In conclusion, Pediatric Anesthesia published "Good Practice in Postoperative and Procedural Pain Management" (37) which recommends that pain assessment should occur as a function of the child's chronological age (Table 1.6).

Table 1.6 "Good Practice in Postoperative and Procedural Pain Management" recommendations (37)
FPS-R = Faces Pain Scale – Revised, VAS = Visual Analogue Scale, NRS = Numerical Rating Scale

Child's age	Measure
Newborn – 3 year	COMFORT or FLACC
4 year	FPS-R + COMFORT or FLACC
5 – 7 years old	FPS-R
7 years old +	VAS or NRS or FPS-R

1.7 Management

Acute pain guidelines should ideally be evidence based. The aim is to provide up to date data which is easily accessible and assists with making decisions on particular patient care issues. The environment in which treatment takes place varies markedly in patient population, size and available resources. As such the effectiveness of an intervention must be continuously measured and evaluated in individual patients. In 1986 the World Health Organisation (WHO) introduced a model on how to initiate and incrementally increase analgesics in the treatment of pain. This is known as the WHO Analgesic Stepladder (Table 1.7). The underlying principle is to start with simple analgesics (i.e. non-opioids). This is advanced to mild and then to strong opioids. Dosing takes place according to the pain intensity reported by the patient. A new adaption of the ladder includes a 4th step with interventional therapy such as nerve block, epidural, PCA therapy, neurolytic block therapy and spinal stimulators.

Table 1.7 Adapted WHO analgesic ladder (39-41)

Step 1	Step 2	Step 3
MILD PAIN	MODERATE PAIN	SEVERE PAIN
	Opioids for mild to moderate pain: codeine, tramadol, propoxyphene, buprenorphine, oxycodone (low dose)	**Opioids for moderate to severe pain:** Morphine, fentanyl, methadone, hydromorphone, oxycodone
Non-opioid analgesics: Paracetamol, aspirin, NSAIDS	**Non-opioid analgesics**	**Non-opioid analgesics**
± Adjuvants: Steroids, anxiolytics, antidepressants Hypnotics, anticonvulsants, gabapentinoids, Membrane stabilisers, sodium channel blockers, NMDA antagonists, cannabinoids	± **Adjuvants**	**± Adjuvants**
Pain score on NRS of 1- 3	Pain score on NRS of 4 -6	Pain score on NRS of ≥ 7

The above-mentioned 3 step approach has been superseded by a 2 step approach. This has been found to be a more effective when treating children with persistent pain due to medical illness, since the risks of codeine usage in the paediatric population has now surfaced. In the two step approach, mild pain is still treated with simple analgesics (paracetamol and NSAIDs), if this is ineffective the next step is to treat the pain as for moderate to severe pain. (39)

Pre-emptive analgesia, is a clinical concept whereby multimodal agents are introduced prior to exposure to the painful stimulus. The aim of this intervention is to prevent sensitization of pain pathways to subsequent stimuli that could intensify the pain. The most efficacious analgesic regimes are those that are able to restrict the degree of sensitization during the whole perioperative period. This will be briefly mentioned throughout the discussion on pain management.

1.7.1 Pharmacological

A detailed discussion of the pharmacology of each of the drugs involved in pain management is beyond the scope of this review. Instead a discussion on the role of these drugs in tonsillectomy surgery will follow.

1.7.1.1. Paracetamol

Paracetamol serves as an analgesic and antipyretic. It is absorbed rapidly and well after oral administration with bioavailability of up 98 % (42). It can also be given rectally and intravenously. There is increasing evidence of central antinociceptive effects. However, its precise mechanism of action remains unclear. It is proposed that it provides its analgesic action via a poorly understood serotonergic mechanism and its anti-inflammatory / antipyretic action via the inhibition of central cyclooxygenase-3. Another possibility is that it regulates the endogenous cannabinoid system.

Paracetamol administered by whichever route, has a clinically relevant, opioid-sparing effect in adults, and inevitably reduces the incidence of PONV. In children, this opioid-sparing effect is variable and dependant on dosage, the route of administration and the duration of therapy. The quantity of paracetamol available to produce a desired effect, is dependent on the route of administration. Bioavailability after oral intake is high with peak plasma concentrations reached in 30 minutes.

Rectal loading doses need to be higher (30 – 40 mg/kg) in order to achieve plasma levels associated with analgesia. This route of administration is slower and less predictable (43). The intravenous formulation reaches predictable peak plasma concentrations more rapidly as first pass metabolism through the gastro-intestinal system is avoided (44). Needless to say appropriate dosing and intense knowledge of the pharmacokinetics as per the route of administration is necessary.

Looking at some studies of paracetamol in patients presenting for tonsillectomy, the following was found(43):

- 40 mg/kg paracetamol per os 40 minutes preoperatively was associated with lower pain scores and less need for morphine in recovery when compared to paracetamol 40 mg/kg per rectum after induction (45)
- 40 mg /kg rectal needed rescue analgesia after a longer time period when compared to 15 mg/kg IV (10 vs 7 h) (46)
- patients who received 15 mg/kg rectal had lower pain scores when measured at four and six hours, were more pain free (44 vs 10 %) and needed rescue analgesia after a longer time (5 vs 3.8 h) when compared to patients who received 10 mg/kg IV
- lower pain scores were found when a single, preoperative oral dose (15 mg/kg) of paracetamol was compared to ibuprofen 10 mg/kg (47)
- the analgesia provided by a combination of paracetamol (15 mg/kg) and diclofenac (1 mg/kg) given was found to be equivalent to that of paracetamol 30 mg/kg orally (48)
- 15 mg/kg IV paracetamol had similar pain scores as meperidine 1 mg/kg. In fact it was associated with less sedation and earlier discharge from the

recovery room. However morphine rescue was required more frequently in those patients who had received paracetamol (17 % vs 0 %) (49)

- 15 mg/kg IV had similar pain relief in the early postoperative period when compared to IV tramadol 1 mg/kg (50)

The conclusion drawn about paracetamol from the above information is that it has opioid sparing capability; dual administration with NSAIDs is favourable on pain scores; the potency of the intravenous formulation is comparable to that of 'intermediate opioids' like pethidine and tramadol; and also effective analgesia occurs faster with intravenous forms due to faster absorption; while the effects wear off faster in comparison to oral and rectal formulations due to metabolism. Paracetamol is also non-sedating, has minimal effects on the respiratory centre and is associated with less PONV.

1.7.1.2 Non-steroidal anti-inflammatories

The term nonsteroidal anti-inflammatory (NSAID) refers to both non-selective (ibuprofen, diclofenac, indomethacin, ketoprofen) and selective cyclooxygenase inhibitors (coxibs e.g. celecoxib, etoricoxib, parecoxib). They exert their effects via the inhibition of cyclooxygenase enzyme thus preventing the synthesis of prostaglandins.

Looking at some studies the following was found (51):

- diclofenac 1mg/kg per rectum after induction vs placebo showed that patients given diclofenac had lower pain scores and lower morphine usage in comparison to the placebo group (52) in the tonsillectomy population
- placebo per os 1 hour prior surgery vs ibuprofen 5 mg/kg 1 hour prior surgery vs rofecoxib 0.625 mg/kg 1 hour prior surgery. Results showed that patients who received rofecoxib needed earlier rescue analgesia when compared to those who received ibuprofen. No difference however was shown at 4 and 24 hours (53)
- ketorolac 1 mg/kg given shortly after induction was compared to ketorolac 1 mg/kg given after surgery. More patients needed rescue analgesia when

ketorolac was given after surgery. This lays emphasis on the favourable outcomes of pre-emptive analgesia. After 5 hours the 2 populations had no difference in their pain scores

- when parecoxib 1 mg/kg was compared to a saline placebo at induction of anaesthesia, worse CHEOPS scores and more rescue analgesics were required in the placebo group (54)

Nonsteroidal anti-inflammatory drugs are useful in the treatment of post-tonsillectomy pain as they are effective in the management of mild to moderate pain. They have also been noted to reduce the incidence of postoperative nausea and vomiting especially when used as an alternative to opioids (52). Usage thereof is associated with a reduction of time to oral intake and earlier discharge(55). There is however a fear that their effect on platelet aggregation may result in clinically significant bleeding. In 2013, a Cochrane Collaboration was published reviewing NSAIDs (51) and peri-operative haemorrhage in children presenting for tonsillectomy. The evidence therein was inconclusive. Insufficient data exists to exclude a statistically significant increase in bleeding when NSAIDs are used. A subgroup of the individual drugs couldn't be created, however ketorolac stood out. The data was inclined to conclude that ketorolac could be better associated with bleeding than the other NSAIDs. A subgroup analysis indicated that there was a non-significant risk of bleeding when NSAIDs were given regularly postoperative. A comparison of the effects of administering NSAIDs one hour before surgery and administering the drug in the PACU was unclear.

The results of the Cochrane Collaboration (51) found that there was possibly a 25 % decrease in PONV. The two postulated mechanisms show less opioid analgesia and better pain control, since pain can lead to nausea and vomiting. The COX-2 inhibitors have lower bleeding risk as they do not affect platelet aggregation. However, paediatric data in terms of selectivity, pharmacodynamic-pharmacokinetic relationship, dosing and side effects, remains poor. This has resulted in limited usage and is a potential topic for research in the field.

1.7.1.3 Ketamine

Ketamine exerts its analgesic action both peripherally and centrally. It is a non-competitive N-methyl-D-aspartate (NMDA) glutamate receptor antagonist with a significant role as an adjuvant in pain associated with central sensitisation. At sub anaesthetic doses it has been shown to be opioid sparing, it reduces the time to first analgesic request and results in fewer incidences of PONV. However, uncertainty exists about its neuropsychiatric effects (hallucinations and nightmares) and increase in secretions.

A review on literature that exists on ketamine in tonsillectomy showed the following:

- three test groups were examined. The first received ketamine 0.5 mg/kg IV which was followed by a continuous infusion as soon as the tonsils were removed; the second group received an infusion at 6 ug/kg/min and the last group a placebo. It was found that pre-emptive ketamine resulted in 23 % tramadol use vs 40 % in the post-surgical stimulus ketamine group, and 66.7 % in the placebo group. The conclusion being that ketamine efficiently reduced pain in the PACU after tonsillectomy when used before surgery (56). Bolus mode was far more effective in decreasing PACU pain scores when compared to a continuous infusion
- peritonsillar ketamine infiltration was compared to topical application during tonsillectomy. Both were associated with a decrease in pain scores in the recovery room and analgesic requirements (57). There is however a potential increase in the risk of haematoma and bleeding with peritonsillar infiltration
- safe and effective pain control can be achieved when ketamine is given at the end of surgery at low-dose (0.1 – 0.5 mg/kg) irrelevant of the route of administration (58)
- low dose ketamine (0.25 mg/kg) given 15 minutes prior to the end of surgery can effectively reduce pain without increasing the rate of adverse effects such as PONV and emergence delirium (58)

Controversy exists over what the effective dose and / or route of administration is when ketamine is co-administered with opioids. Also, it has been found that the addition of ketamine to a regime containing opioids might result in synergism and thus sedation making the results of pain assessment tools difficult to interpret (57).

1.7.1.4 Opioids

Children experience significant pain when they come for tonsillectomy. The optimal result is often achieved when regularly administered mild analgesics are combined with slowly titrated opioids therapy. A variety of opiates has been suggested, but the adverse effects and associated morbidity and mortality has led to a persistent review of their usage in this population. Opioids are known to cause nausea, vomiting, sedation and respiratory suppression. Caution needs to be exercised in prescribing opioids in children with OSA, as these medications can contribute to increased airway obstruction postoperatively. A review of anaesthesia and “Opioid related malpractice claims following tonsillectomy” (both adult and paediatric) in the USA (3) found that of the 242 reports 98 (40.5 %) were fatal and 144 (59.5 %) nonfatal (Table 1.8). The commonest cause of fatal injury were related to surgery(39.8 %), followed by anaesthesia (36.7 %) and opioid related (16.3 %). The remaining 17.4 % was uncategorised.

Table1.8 Categories of fatal and non-fatal injury claims (3)

	Fatal injury claims n (%) 98 (40.5)	**Nonfatal injury claims n (%) 144 (59.5)**	**Examples**
Surgery related	39 (39.8 %)	101 (70.1 %)	Bleeding, soft tissue injury, burns, infection
Anaesthesia related	3 (36.7 %)	32 (22.2 %)	Non opiate medications, difficult airway, aspiration
Opioid related	16 (1.3 %)	6 (4.2 %)	Morphine and codeine most frequent offender, followed by fentanyl and meperidine
Uncategorised	17 (17.4 %)	9 (6.3 %)	

Codeine in the United States, due to its availability and perceived margin of safety (3, 12) has previously been one of the most prescribed opioids for postoperative pain following a tonsillectomy. The risk inherent in the administration of codeine in children (age < 18 years) following a tonsillectomy, has resulted in a recent (February 2013) black box warning by the Food and Drug Administration (FDA). The European Medicines Agency (EMA) has followed suite (43). Codeine is a pro-drug converted into morphine by the cytochrome P450 enzyme. This by-product has a greater affinity and higher intrinsic activity at the opioid receptors than codeine itself (42). The problem is that the pharmacodynamics may be genetically altered in a subgroup of patients resulting in variable responses to codeine. Ultra-rapid metabolisers (UM) have enhanced metabolism of codeine to morphine resulting in potentially fatal toxicity risks.

A similar problem applies to tramadol, oxycodone and hydrocodone. A solution to this problem would be diagnostic tests that assess the polymorphism of the CYP2D6 enzyme. However, due to limited access and financial implications, this has not gained favour. Interestingly, tramadol has gained increasing use in children as it is effective against mild to moderate pain with fewer opioid effects such as respiratory depression, sedation and constipation. There is however an association with increased risk of nausea and vomiting in certain patients (37), and it may precipitate seizures and serotonergic syndrome (24). Pethidine (meperidine) is typically not administered in children due to the risk of convulsions. The understanding of opioids in the paediatric practice is limited by the number of studies available. These are but some factors that have contributed to practitioners being reluctant to give long acting opiates to children in the perioperative period.

1.7.1.5 Steroids

Postoperative nausea and vomiting (PONV) is a common morbidity in paediatric tonsillectomy. It has an incidence rate of about 70 % if no prophylactic anti-emetic therapy is given(1). Patients who have PONV often have to stay in-hospital overnight. It may even worsen the experience of pain, and lead to general patient and parent dissatisfaction. In 2011 the Cochrane Collaboration published a report, “Steroids for Improving Recovery following Tonsillectomy in Children”(59). The

primary objective was to review how effective a single dose of dexamethasone was in decreasing morbidity after a tonsillectomy. Outcome measures were occurrence of emesis, return to a soft or solid diet, and pain at 24 hours as measured on a visual analogue scale.

The results suggest that when dexamethasone is used, there is a reduction in the incidence of emesis during the first 24 hours. This mechanism still remains unclear. The early return to regular diet after dexamethasone is mostly likely due to a combination of factors including: elation of mood, stimulation of appetite, anti-emetic and anti-inflammatory effects. Meta-analysis of studies examined demonstrated less postoperative pain in patients who had received a steroid, however the importance of this should be interpreted with caution. The potential, yet rare risks of corticosteroid therapy, include postoperative bleeding, increased risk of infection, elevations in glucose levels, and avascular joint necrosis. There is also the fear that steroids can mask bleeding because patients keep swallowing blood instead of vomiting it out. However, the opinion is that a single, low bolus dose should not be associated with these complications. However, this doesn't imply that these cannot occur.

An appropriate discussion with patient, family and healthcare practitioner should take place about the risks and benefits. The most frequently used dose of dexamethasone in studies is that of 0.5 mg/kg. However doses can range from 0.15 to 1 mg/kg with a maximum of 8 to 25 mg (9). The question of appropriate dose remains unanswered according to this collaboration and final recommendations on this point await randomised dose-control trials, but for current practice a dose of 0.15 mg/kg of dexamethasone seems efficacious (28, 60). Given the frequency of tonsillectomy surgery and the inexpensive and safe nature of a single dose of dexamethasone, evidence suggests that this be routinely used to reduce morbidity.

1.7.1.6 Others

- Local anaesthetics

Intraoperative, local anaesthesia injection in the tonsillar fossa has been used to reduce morbidity. A Cochrane review (61) looked at “Perioperative local anaesthesia for reducing pain following tonsillectomy”. Six trials met inclusion criteria, one involved topicalisation by local anaesthetic spray while the other five had peritonsillar injection of the local anaesthetic. No evidence was found to prove that local anaesthesia contributed significantly to the reduction of postoperative tonsillectomy pain in adults and children (61). Trials used were however small, and several of the patients had also received opioids which potentially confounded the benefits of local anaesthetic. Concerns have been raised about local infiltration of these agents with complaints of increased risk of bleeding, haematoma and intravascular injection being just a few. Further research is necessary to elicit the proposed benefits of improved pain scores and earlier oral intake in patients post-tonsillectomy.

- Intraoperative hydration

The use of supplemental hydration may be a cheap method of reducing the incidence of PONV, especially if fasting guidelines have not been adhered to. Various studies have assessed this in adults and found controversial results. Elgueta et al (62) performed a randomised control trial in children presenting for tonsillectomy. Two populations were looked at. One received 10 ml/kg of Ringers lactate solution (control) while the other 30 ml/kg. The incidence of PONV was shown to decrease by 24 % (82 % in the 30 ml/kg vs 62 % in the 10 ml/kg group). The mechanism is unclear. However, a decrease in nausea and vomiting was noted to be associated with a decrease in pain. Also, fasting is associated with a decrease in intravascular volume which causes hypoperfusion to the gut. This leads to an increase in serotonin production, and possible emesis (62). My conclusion is that at the very least we have to ensure that children presenting for tonsillectomy are appropriately fasted, and receive adequate perioperative hydration so as to decrease the occurrence of POV and subsequently that of postoperative pain.

- Gabapentinoids

Several recent adult studies in post-tonsillectomy pain have looked at the usage of the gabapentinoids (gabapentin and pregabalin) as an adjuvant. The findings suggest that a single, preoperative dose of gabapentinoids has an effect on post-tonsillectomy pain, the usage of opioids, PONV and reduced incidence of side effects. Currently there is insufficient data to support the routine use of these drugs when treating tonsillectomy pain in children.(63)

- Honey

Honey has been shown to improve post tonsillectomy pain and consumption of analgesics when given postoperatively. This has been associated with little improvement in healing of the tonsillar fossa. Honey didn't produce any major adverse effects such as infection and bleeding. Further research is required to evaluate the dose and duration of administration required to show beneficial effect in children after tonsillectomy.(64)

Recommendations for pain management in tonsils from the "Pediatric Anesthesia Good Practice in Postoperative and Procedural Pain Management" (37), are that simple analgesics in the form of NSAIDs and paracetamol should be regularly administered in the perioperative period. This should be combined with intraoperative opioids and dexamethasone. The usage of local anaesthetic by topicalisation or peritonsillar injection was not found to improve early pain scores. Tramadol was noted to elicit analgesia similar and comparable to morphine and pethidine (meperidine). However, the analgesic effects of intra-operative intravenous ketamine didn't compare to those of an opioid, and in fact caution was advised when using the two concurrently. The implementation of standardised protocols based on the above information was suggested. This resulted in less pain and acceptable incidences of PONV. Finally, no benefit was found when analgesia was administered on a fixed schedule when compared to it being given only when needed i.e. pro re nata (65).

1.7.2 Non-pharmacological

Non pharmacological pain therapy should always be considered when treating acute pain. Psychological interventions such as tactile stimulation, especially from a parent or caregiver; guided imagery, distraction and hypnosis are a few that can be considered (37). Parental presence at appropriate periods is encouraged in paediatric pain care. Parental anxiety, fear and uninformative reassurance (told e.g. not to worry), heightened the child's fear. Distraction techniques and informative reassurance decreased it (43). Pre-procedural preparation of both the parent and child should be encouraged and made part of routine hospital practice (43).

1.8 Controversies

1.8.1 Ambulatory vs in-patient

Many tonsillectomies are performed in the outpatient setting. However, there are children who are at higher risk for complications (particularly respiratory complications thus necessitating overnight observation). Recommendations previously published for the organisation of paediatric ambulatory surgery and patient selection (www.adarpef.org) are presented as adapted to tonsillectomy by the virtue of predictability of postoperative course (66). Ambulatory tonsillectomy is feasible if the child is 3 years or older, ASA 1 or 2, and is free of comorbidity liable to worsen the respiratory risks, and is free from a bleeding disorder.

In ambulatory surgery it is recommended to ensure that the caregiver fully understands the need of surveillance at home, complies with the postoperative prescription, and knows what complications to look for (66). Ideally, they should be able to return to the hospital within an hour (67). Organisational criteria that have to be met include:

- surgery should ideally be performed in the morning on a schedule compatible with 6 hour surveillance (primary bleeding is most likely to occur in the first 4 hours postoperative)(67);

- the anaesthetist should have adequately planned for and prevented or treated incidences of PONV and pain;
- initial oral analgesia should have been initiated;
- on discharge parents should have written information on surveillance criteria, resumption of feeding, and a 24 hour contact number in case of complications.

Children at high risk for respiratory complications should have overnight hospitalisation, ideally with pulse-oximetry monitoring. These may include any of the following: age < 3 yr; persistent desaturation in recovery; severe OSA (as assessed by polysomnography, with AHI > 10 and / or SaO_2 < 80 %); associated comorbidities such as cardiac disease, failure to thrive, obesity, craniofacial anomalies, chromosomal anomalies like Downs, neuromuscular disorders such as cerebral palsy, bleeding disorder or recent URTI (24, 28). Whether in-patient or ambulatory, prior to discharge, the following criteria should be met: tonsils free of blood on pharyngeal examination, pain under control, no PONV, temperature ≤ 38 ˚C, and that parents understand about home surveillance.

1.8.2 Antibiotics

The early belief was held that antibiotics reduced postoperative morbidity presumably by reducing the number of bacteria or possibly by the anti-inflammatory effects displayed by certain groups of antibiotics (9). Colonisation of the exposed peritonsillar bed by local flora possibly produces a local inflammatory reaction that worsens pain post-tonsillectomy (68). Perioperative use of antibiotics (24 hours before and following surgery) was thus considered to be beneficial. Substantial literature has been published since then, resulting in the 2012 Cochrane Collaboration review titled “Antibiotics to reduce post-tonsillectomy morbidity” (69). The primary outcomes that were assessed were: secondary haemorrhage, pain and the usage of analgesia. Secondary outcomes were: pyrexia, time taken to first oral intake, return to normal activities, and the occurrence of any complications. Ten trials were found eligible.

Antibiotics were not found to be effective in reducing analgesic requirements, neither were they found to decrease the incidence of secondary bleeding. In terms of secondary outcomes, there was a decrease in pyrexia but an increase in complications seen such as skin rash and diarrhoea. Inappropriate antibiotic usage promotes bacterial resistance, which is of concern in infants who may require antibiotic therapy for several other infections they may encounter. These findings discourage the routine usage of antibiotics Subsequent reviews and commentaries have reflected this same sentiment (9). However, should the child present with features in keeping with an infection or there is an established indication for antibiotics prophylaxis e.g. to prevent endocarditis, then antibiotics are indicated (68).

1.8.3 Emergence delirium

Emergence delirium (ED) is defined as a “dissociative state of consciousness in which the child is irritable, uncompromising, uncooperative, incoherent and inconsolably, crying, moaning, kicking or thrashing” (70). In addition, children may display paranoid characteristics in combination with these emergence behaviours.
These children do not recognise familiar and known objects, or people such as their parents. Parents claim that this is particularly frightening. Although it has a self-limiting duration, about 5 – 15 minutes, the episode can often result in physical injury to the operated site and to the child. Once it occurs, extra nursing care is needed, and often additional sedatives or analgesia are prescribed. This may be associated with the depression of respiration or airway obstruction thus delaying patient discharge.

The estimated incidence is anywhere between 2 and 80 % (27). The large variability in incidence may be due to the lack of standardised, validated tools and variable definition of emergence delirium (71). This is considered a neurological complication, and has been associated with preoperative anxiety. The incidence of emergence delirium / agitation depends on the definition, age, anaesthetic technique, surgical procedure, and the usage of adjunct drugs. Risk factors contributing to emergence delirium in children are: age (particularly preschool children between the ages of two

and five years); emergence agitation which is defined as “a state of mild restlessness and mental distress that, unlike delirium, does not always suggest a significant change in behaviour”; male gender; sevoflurane and desflurane anaesthesia; otorhinolaryngological procedures; preoperative anxiety; and postoperative pain (26, 27).

Due to the large overlap in clinical presentation, it has been difficult to differentiate pain and ED in the postoperative period. Postoperative pain may be the cause of agitation, especially after short surgical procedures where the peak effects of analgesics only occurs after the child is fully awake. Some studies have shown that the pre-emptive management of pain successfully reduced emergence delirium, thus suggesting that pain may be its main source (27). However, post-anaesthesia agitation has also been seen in procedures associated with no pain e.g. magnetic resonance imaging scanning. This clearly suggests that ED is a separate phenomenon to pain. The dilemma then lies in how to differentiate primary delirium from pain related behaviour, especially because the management differs between the two.

Somaini et al published a thought provoking paper in the British Journal of Anaesthesia titled “Emergence delirium or pain after anaesthesia – how to distinguish between the two in young children: a retrospective analysis of observational studies” (72). They recognised that early postoperative negative behaviour (e-PONB) is a common problem in young children presenting for general anaesthesia. The two clinical components of e-PONB were identified as ED and postoperative pain, which have divergent trends over time in the early postoperative phase. The Paediatric Anaesthesia Emergence Delirium (PAED) scale, the only validated scale to quantify ED, and the most commonly used composite pain assessment scales during the postoperative period, were used to characterise ED and pain. Interestingly, it was found that there is some overlap with shared descriptors with e.g. the FLACC scale. This may produce an artificial overlap with overestimation of pain and / or ED.

Somaini et al's analysis of available literature found that "no eye contact" and "no awareness of surroundings" are typical characteristics of ED. The characterisation of pain was more complicated, but the association of "abnormal facial expression, crying and inconsolability" demonstrated high sensitivity and specificity to detect pain in young children during the first 15 minutes after awakening. Emergence delirium was also an early diagnosis with self-limiting behaviour, beginning at awakening and resolving within 15 minutes, even without pharmacological intervention. No children complained of pain as first behaviour. The suggestion was thus; if a child presents with e-PONB, clinicians should observe the child for 5 minutes(72). If behaviour persists, then the clinician should consider pain treatment as the primary option. No comment is made on the value of self-report scales. The opinion of the author being that self-report may be an easier tool of evaluation, where one waits until the child is coherent enough to state that they are experiencing pain, and what severity it may be.

1.9 References

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SECTION 2: Journal guidelines to authors

This section highlights the guidelines which the author has followed with regards to the length and formatting of the research article.

The guidelines followed in creating the draft article were those of the Southern African Journal of Anaesthesia and Analgesia, which is the intended journal of publication.

Article sections and length

The following contributions are accepted (word counts exclude abstracts, tables and references):

Original research (2800 – 3200 words / 4 – 5 pages)

FULL AUTHOR GUIDELINES

Title page
All articles must have a title page with the following information and in this particular order: Title of the article; surname, initials, qualifications and affiliation of each author; The name, postal address, e-mail address and telephonic contact details of the corresponding author and at least 5 keywords.

Abstract
All articles should include an abstract. The structured abstract for an Original Research article should be between 200 and 230 words and should consist of four paragraphs labeled Background, Methods, Results, and Conclusions. It should briefly describe the problem or issue being addressed in the study, how the study was performed, the major results, and what the authors conclude from these results. The abstracts for other types of articles should be no longer than 230 words and need not follow the structured abstract format.

Keywords
All articles should include keywords. Up to five words or short phrases should be used. Use terms from the Medical Subject Headings (MeSH) of Index Medicus when available and appropriate. Key words are used to index the article and may be published with the abstract.

Acknowledgements
In a separate section, acknowledge any financial support received or possible conflict of interest. This section may also be used to acknowledge substantial contributions to the research or preparation of the manuscript made by persons other than the authors.

References
Cite references in numerical order in the text, in superscript format (Format> Font> Click superscript). Please do not use brackets or do not use the foot note function of MS Word.

In the References section, references must be typed double-spaced and numbered consecutively in the order in which they are cited, not alphabetically.

The style for references should follow the format set forth in the Uniform Requirements for Manuscripts Submitted to Biomedical Journals (http://www.icmje.org) prepared by the International Committee of Medical Journal Editors. Abbreviations for journal titles should follow Index *Medicus* format. Authors are responsible for the accuracy of all references.

Personal communications and unpublished data should not be referenced. If essential, such material should be incorporated in the appropriate place in the text.

List all authors when there are six or fewer; when there are seven or more, list the first three, then ";et al."; When citing URLs to web documents, place in the reference list, and use the following format: Authors of document (if available). Title of document (if available). URL. (Accessed [date]).

The following are sample references:

1. Jun BC, Song SW, Park CS, Lee DH, Cho KJ, Cho JH. The analysis of maxillary sinus aeration according to aging process: volume assessment by 3-dimensional reconstruction by high-resolutional CT scanning. Otolaryngol Head Neck Surg. 2005 Mar;132(3):429-34.
2. 2. Polgreen PM, Diekema DJ, Vandeberg J, Wiblin RT, Chen YY, David S, et al. Risk factors for groin wound infection after femoral artery catheterization: a case-control study. Infect Control Hosp Epidemiol [Internet]. 2006 Jan [cited 2007 Jan 5];27(1):34-7. Available from: http://www.journals.uchicago.edu/ICHE/journal/issues/v27n1/2004069/2004069.web.pdf.

More sample references can be found at:
http://www.nlm.nih.gov/bsd/uniform_requirements.html"

Tables
Tables should be self-explanatory, clearly organised, and supplemental to the text of the manuscript. Each table should include a clear descriptive title on top and numbered in Roman numerals (I, II, etc) in order of its appearance as called out in text. Tables must me inserted in the correct position in the text. Authors should place explanatory matter in footnotes, not in the heading. Explain in footnotes all non-standard abbreviations.

For footnotes use the following symbols, in sequence:*,†,‡,§,||,**,††,‡‡

Figures
All figures must be inserted in the appropriate position of the electronic document. Symbols, lettering, and numbering (in Arabic numerals e.g. 1, 2, etc. in order of appearance in the text) should be placed below the figure, clear and large enough to remain legible after the figure has been reduced. Figures must have clear descriptive titles.

Photographs and images
If photographs of patients are used, either the subject should not be identifiable or use of the picture should be authorised by an enclosed written permission from the subject. The position of photographs and images should be clearly indicated in the text. Electronic images should be saved as either jpeg or gif files. All photographs should be scanned at a high resolution (300dpi, print optimised). Please number the images appropriately.

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Permission should be obtained from the author and publisher for the use of quotes, illustrations, tables, and other materials taken from previously published works, which are not in the public domain. The author is responsible for the payment of any copyright fee(s) if these have not been waived. The letters of permission should accompany the manuscript. The original source(s) should be mentioned in the figure legend or as a footnote to a table.

Review and action
Manuscripts are initially examined by the editorial staff and are usually sent to independent reviewers who are not informed of the identity of the author(s). When publication in its original form is not recommended, the reviewers' comments (without the identity of the reviewer being disclosed) may be passed to the first author and may include suggested revisions. Manuscripts not approved for publication will not be returned.

Ethical considerations
Papers based on original research must adhere to the Declaration of Helsinki on ";Ethical Principles for Medical Research Involving Human Subjects"; and must specify from which recognised ethics committee approval for the research was obtained.

Conflict of interest
Authors must declare all financial contributions to their work or other forms of conflict of interest, which may prevent them from executing and publishing unbiased research. [Conflict of interest exists when an author (or the author's institution), has financial or personal relationships with other persons or organizations that inappropriately influence (bias) his or her opinions or actions.]* *Modified from: Davidoff F, et al. Sponsorship, Authorship, and Accountability. (Editorial) JAMA 2001: 286(10) The following declaration may be used if appropriate: ";I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in writing this paper."

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The Editor, SAJAA, E-mail: toc@sajaa.co.za

Note: Ensure that the article ID [reference] number is included in the subject of your email correspondence.

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Authors with no e-mail or internet connection can mail their submissions on a CD to: SAJAA, PO Box 14804, Lyttelton Manor, 0140, Gauteng, South Africa.

All manuscripts will be processed online. Submissions by post or by e-mail must be accompanied by a signed copy of the following indemnity and copyright form. CLICK HERE to download and save it to your computer.

Tips on Preparing your manuscript

1. Please consult the “Uniform requirements for manuscripts submitted to biomedical journals” at www.icmje.org
2. Please consult the guide on Vancouver referencing methods at: http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=citmed.TOC&depth=2
3. The submission must be in UK English, typed in Microsoft Word or RTF with no double spaces after the full stops, double paragraph spacing, font size 10 and font type: Times New Roman.
4. All author details (Full names, Qualifications and affiliation) must be provided.
5. The full contact details of corresponding author (Tel, fax, e-mail, postal address) must be on the manuscript.
6. There must be an abstract and keywords.
7. References must strictly be in Vancouver format. (Reference numbers must be strictly numerical and be typed in superscript, not be in brackets and must be placed AFTER the full stop or comma.)
8. It must be clear where every figure and table should be placed in the text. If possible, tables and figures must be placed in the text where appropriate. If too large or impractical, they may be featured at the end of the manuscript or uploaded as separate supplementary files.
9. All photographs must be at 300dpi and clearly marked according to the figure numbers in the text. (Figure 1, Table II, etc.)
10. All numbers below ten, without percentages or units, must be written in words.
11. Figure numbers: Arabic, table numbers: Roman

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SECTION 3: Draft article

Audit of peri-operative pain management in paediatric patients following tonsillectomy at a tertiary hospital in Johannesburg

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Keywords:
Anaesthesia, paediatric, tonsillectomy, pain management, audit

Abstract

Background

Adeno-tonsillectomy remains one of the most frequently performed surgical procedures in children. Despite improvements in anaesthetic and surgical techniques, severe pain is reported in as many as 25 – 50 % of children. Pain assessment and knowledge of drug pharmacodynamics and pharmacokinetics in the paediatric patient, is a prerequisite for optimal care. Much has been written on peri-operative pain management following tonsillectomy. However, no consensus has been reached on what the ideal analgesic regime should be.
This audit is a review of current practice at Chris Hani Baragwanath Academic Hospital. It aims to identify problems and develop possible solutions to improve anaesthetic practice.

Methods

A prospective, contextual, descriptive study design using a data collection sheet was used on paediatrics patients presenting for tonsillectomy.

Results

Eighty five patients aged three to 12 years of age, with ASA grading I or II were enrolled in the study. The choice of anaesthetic was variable with a combination of simple analgesics, opioids and adjuvants. This affected postoperative pain scores. Snare dissection and monopolar cautery haemostasis, was the standard surgical technique. Surgical seniority influenced the duration of tonsillectomy, with an effect on postoperative pain scores.

Conclusions

Audits are necessary to evaluate what resources are needed to optimise care. The occurrence of pain after tonsillectomy continues to be poorly managed. Appropriate premedication and no more than two hours of starvation (after clear liquid ingestion) needs to be introduced. Where possible surgical technique should involve bipolar cautery and be limited to less than 45 minutes. A preemptive, multimodal, opioid-sparing anaesthetic should be routinely practiced.

Introduction

Adeno-tonsillectomy remains one of the most frequently performed surgical procedures in children. It presents risks and challenges for both surgeon and anaesthetist.[1-3] Despite improvements in anaesthetic and surgical technique, poor pain control, postoperative nausea and vomiting (PONV), and emergence delirium continue to be common complications. In fact, severe pain is reported in as much as 25 – 50 % of children presenting for adeno-tonsillectomy.[4] Acute pain is defined as a "normal, predicted, unpleasant sensory and emotional response to an adverse chemical, thermal or mechanical stimulus". [5, 6] This definition recognises both the physiological and affective nature of the pain.

Multiple factors contribute to the experience of pain. A systematic review published in 2016 titled, "Predisposing, precipitating, perpetuating and present factors predicting anticipatory distress to painful medical procedures in children", looked at this. Of note is the high positive relationship between anticipatory anxiety and the level of postoperative pain, the role that parental anxiety plays, and the role that idiosyncratic needs such as fatigue, hunger, dehydration and nausea have on children's anticipatory distress. [7] Surgical techniques also contribute to pain. Often the choice will be based on surgeon preference, experience and instrumentation available. Cold dissection (scalpel, guillotine and snare) and hot dissection (monopolar and bipolar electrocautery) are commonly described. [8, 9] Coblation, laser and the microdebrider are less frequently used. All these techniques are associated with variable postoperative pain intensities.

Pain assessment is imperative for optimal pain management. Without appropriate methods of assessment, it is difficult to plan adequate interventions; and to take the necessary steps to ensure their effectiveness. One suggested approach is that of QUESTT [10]:

- "Question the child;
- Use the age and developmentally appropriate pain rating scales;
- Evaluate behaviour and physiological changes;
- Secure parental involvement;
- Take the cause of pain into account;
- Take action and evaluate results".

Most of the pain rating scales are not validated, applicable to all age groups or universally accepted. In general it is recognised that there are physiological measures, behavioural measures and self-report.[10-12] Self-report is often referred to as the 'gold standard' as it is a direct measure of pain. The self-report tool used must be appropriate to the child's age and developmental level; it must be practical to use in the clinical setting; it should be reproducible, reliable and valid; and ideally transferable between assessors. These tools can be used in children as young as three years of age.[10] However, one must be aware that they may be subject to individual response biases, reflecting the child's interpretation of the pain report [13], thus resulting in misleading scores. For this reason it is advised that self-report scales be corroborated with observational measures in children younger than five years of age.

Anaesthetic techniques that contribute to perioperative pain are difficult to isolate. The use of suitable premedication has been found to decrease anticipatory anxiety associated with surgery, and potentially contribute to the decrease in occurrence of early postoperative negative behaviour i.e. emergence delirium and pain.[14, 15] Pain management varies markedly depending on practitioner preference, resources, surgeon, and patient population. It is difficult to apply a "one size fits all" recommendation, and the efficacy of any intervention must be assessed and titrated in individual patients. A large number of otherwise healthy children undergo tonsillectomies which are often associated with significant pain. This provides a useful model for the study of perioperative pain in the paediatric patient. Findings from this population can be used to assess the system for other surgical procedures.

An audit is part of a cycle of quality assurance. It is a review of current practice, identification of problems, and the development of possible solutions with the aim of implementation and improvement in response to the analysis.[16] This study aimed to examine current strategies employed in patients presenting for adenotonsillectomy, by reviewing anaesthetic and surgical techniques and prescription, and their contribution to postoperative pain.

Method

Ethical approval for this study was sought from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand. Approval for conducting the study was obtained from the Postgraduate committee, and the Chief Executive Officer (CEO) of Chris Hani Baragwanath Academic Hospital (CHBAH). A prospective, contextual, descriptive research design was used. A comprehensive information letter and clear explanation of the study was given to the parent or caregiver of all participants; and signed informed consent was mandatory prior to inclusion in the study. In-hospital data was collected from the anaesthetic and surgical records. All information was captured anonymously in a data collection form. A summary of the questionnaire is shown in Table I.

Table I: Summary of the questionnaire (data collection form)

Section	**Intention**	**Description**
Patient information	Demographic characteristics	Age, gender, weight, ASA rating and fasting duration
Intraoperative information	Anaesthetic and surgical information	Anaesthetic and surgical expertise, times, techniques and complications
Postoperative information	Pain scores and complications	Perioperative pain rating: preoperative, at first verbalisation, 30 minutes and three hours postoperative, and at discharge; postoperative prescription; complications and parental satisfaction

The following patients were excluded from the study:

- Emergency surgery
- ASA III to V, presence of confirmed genetic or metabolic syndrome
- Children with behavioural disorders or cognitive impairment
- A history of chronic pain or preoperative use of analgesic drugs
- Any patients requiring preoperative sedation or total intravenous anaesthesia
- Any patient in whom consent could not be obtained
- Participants in whom it was not possible to use the Wong-Baker pain scale

In consultation with a biostatician, an appropriate sample size was calculated at 62 – 82 patients. The sample size estimation was based on one of the key research questions which was the identification of the presence of pain (Wong Baker score $\geq$ 4/10).

Data was captured onto a Microsoft Excel® 2010 spreadsheet and analysed using SAS® (version 9.4 for Windows). Descriptive analysis of the data was carried out as follows:

- Categorical variables were summarised by frequency and percentage tabulation, and illustrated by means of bar charts.
- Continuous variables were summarised by median and interquartile range, and their distribution illustrated by means of histograms.
- For tests of association, the pain scores were categorised as 0-2 (none/mild), 4-6 (moderate), 8-10 (severe).

The X^2 test was used to assess the relationship between categorised pain score and categorical variables. Fisher's exact test was used for 2 x 2 tables or where the requirements for the X^2 test could not be met. The strength of the associations was measured by Cramer's V and the phi coefficient respectively. The following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

The relationship between categorised pain score and continuous variables was assessed by the t-test (or ANOVA test for more than two categories). Where the data did not meet the assumptions of these tests, a non-parametric alternative, the Wilcoxon rank sum test (or the Kruskal-Wallis test for more than two categories) was used. The strength of the associations was measured by the Cohen's d for parametric tests and the r-value for the non-parametric tests. The following scale of interpretation was used:

0.80 and above	large effect
0.50 to 0.79	moderate effect
0.20 to 0.49	small effect
below 0.20	near zero effect

The 5% significance level was used i.e. p-values <0.05 indicate significant associations.

Results

Ninety seven patients aged three to 12 years of age, with ASA grading I (84%) or II, who underwent an elective adeno-tonsillectomy were enrolled in the study. Twelve children had to be excluded due to incomplete data collection sheets. Fifty one percent of the patients were female. Demographic data, fasting period and duration of surgery and anaesthesia is displayed in table II.

Table II Demographics, fasting, surgical and anaesthetic duration

Variable	**N**	**Median**	**Interquartile range**		**Minimum**	**Maximum**
Age (y)	85	5	4	7	3	11
Weight (kg)	85	18.3	15.6	23.0	10.4	46.0
Fasting duration (h)	85	13.2	11.9	14.4	10.3	18.5
Surgery duration (min)	85	20	15	35	5	125
Anaesthesia duration (min)	85	45	35	60	15	146

The majority of the procedures were performed in the presence of an anaesthetic consultant / principal medical officer (PMO) (55 %), while 37 % and 8 % were performed by senior and junior registrar respectively. Five percent (n=4) of the population received premedication in the form of paracetamol (n=1), midazolam (n=1) and dexmedetomidine (n=2). Fifty two percent of the patients received intraoperative prophylactic antibiotics in the form of cephazolin or augmentin.

Medication given intraoperatively is documented below (Figure 1). Note that 86 % (n=66) of the patients received intravenous paracetamol, and the remainder by rectum (n=11). The status of the remainder of the patients was unknown. Eleven percent (n=9) had local anaesthetic infiltrated in the tonsillar bed by the surgeon.

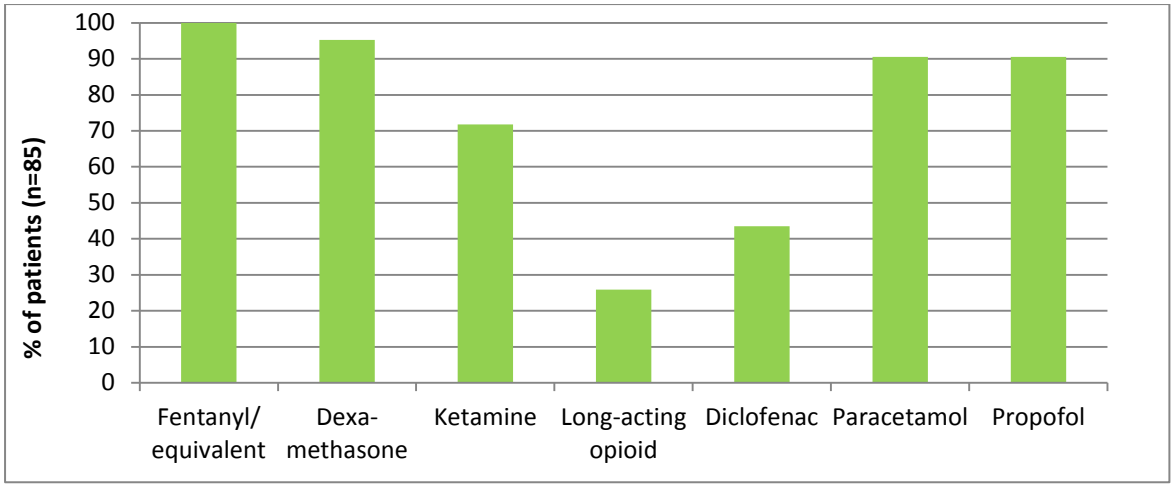

Figure 1 Intraoperative medication given
Fentanyl / equivalent = fentanyl, sufentanyl or alfentanyl; Long-acting opioid = morphine or tramadol

Intraoperative complications occurred in 15 % (n=13) of the population. This included issues pertaining to the airway (laryngospasm, bronchospasm, hypercarbia, need to reintubate), bleeding and injury to tongue and teeth. Eighty six percent (n=73) of the patients were extubated awake.

Tonsil size was predominantly grade II (41 %) and III (32 %), and surgical technique was routinely by cold steel dissection and haemostasis achieved with unipolar diathermy. The majority of the surgeries were performed by registrars (45 %) and consultants (36 %), while only 19 % were performed by a medical officer.
The percentage of children who were prescribed postoperative medication, for the ward as per the surgeon's prescription, is shown below (Figure 2).

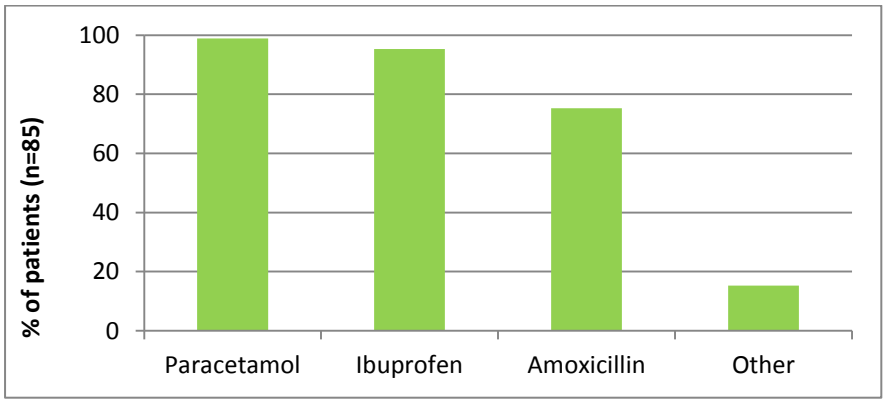

Figure 2 Postoperative medication
Other = bactroban ointment; ranitidine; beclometazone, fluticasone nasal spray; saline nose drops; prednisone; chlorpheniramine; glycothymol oral wash

Complications in the recovery room, occurred in 97 % (n=82) of the population. These included: pain 97 %; restlessness 32 %; PONV 5 %; airway problems in the form of stridor and snoring 5 %; and drowsiness 2%. Eighteen of the 82 children, who experienced pain, were given analgesics in the recovery room in the form of fentanyl, paracetamol or tilidine drops. The most common complication in the ward was ongoing pain (72 %). No rescue analgesia was given in the ward; instead it was given according to a combination of factors including: time of arrival from theatre; schedule as per nursing analgesic round; and ability to take orally.
The pain profile of the patients across the five measurement occasions is shown below (Figure 3). The percentage of patients with severe pain (score 8 or 10) decreased from 72 % at first verbalisation to 53 % at 30 minutes, to 25 % at three hours, to 4 % at discharge.

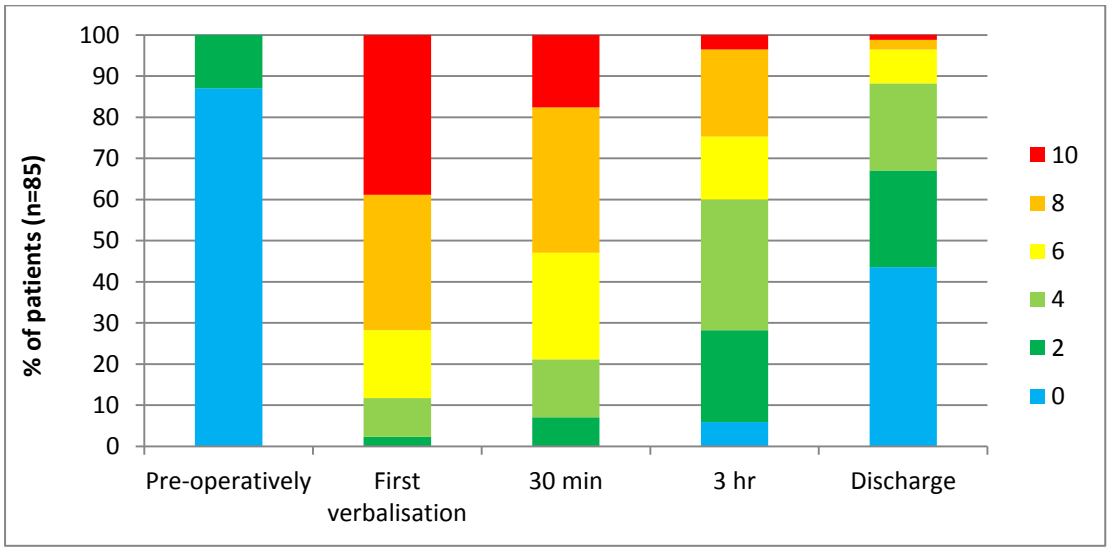

Figure 3 Pain profiles of patients across the five measurement occasions (presence of pain taken as Wong-Baker score ≥ 4/10)

There was a significant, moderate association between categorised pain score at first verbalisation and anaesthetist rank (p=0.010; phi coefficient=0.37). The percentage of patients with a severe pain score was higher for consultants/PMOs (83%) compared to senior or junior registrars (61 and 43% respectively) (Figure 4).

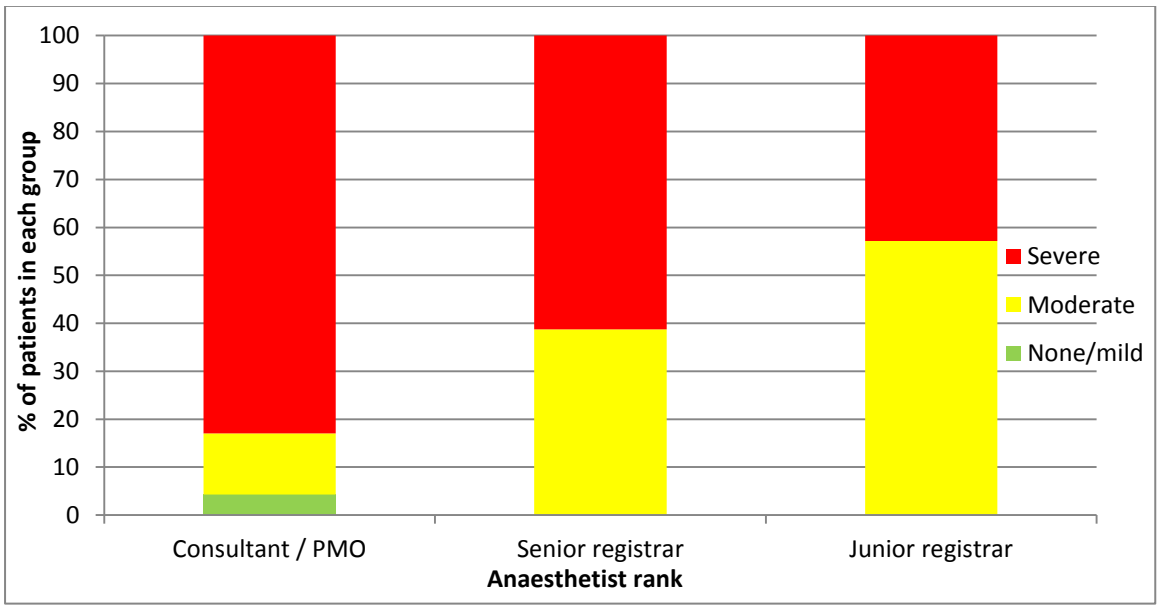

Figure 4 Comparison of categorised pain score at first verbalisation and anaesthetic rank
None/mild pain = Wong Baker score ≤ 2/10; Moderate = 4-6/10 and Severe ≥ 8/10

There was also a significant, moderate association between categorised pain score at discharge from recovery and anaesthetist rank (p=0.0050; phi coefficient=0.47). The percentage of patients with a severe pain score was lower for consultants / PMOs and senior registrars (2 and 0% respectively) compared to junior registrars (29%) (Figure 5).

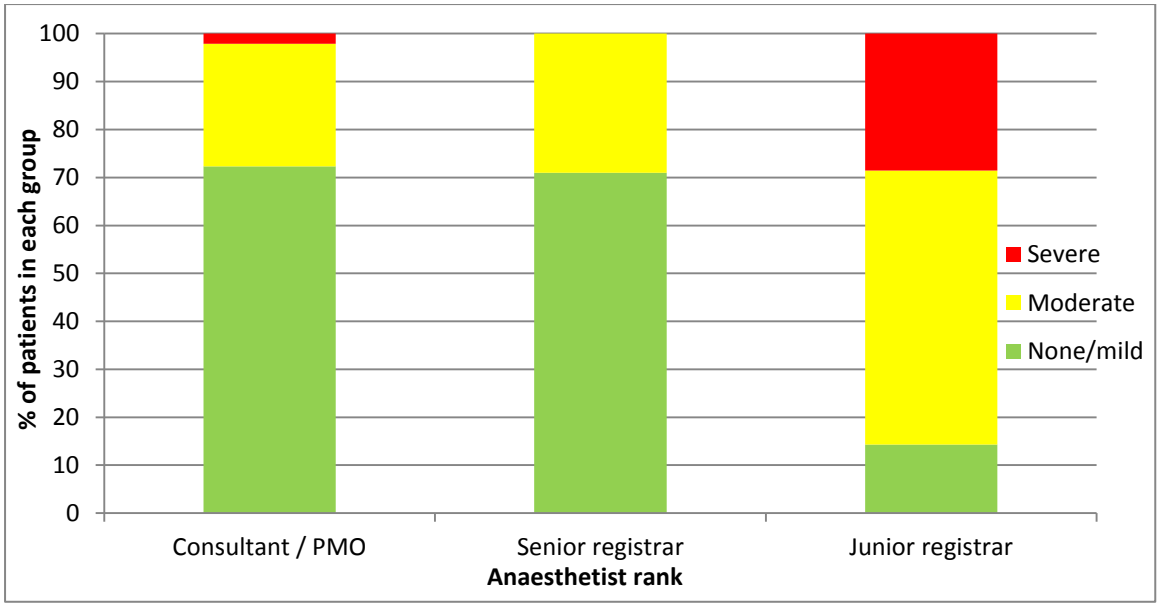

Figure 5 Comparison of categorised pain score at discharge from recovery and anaesthetic rank

There were no significant associations between anaesthetist rank and pain scores at the other two time points. There was a significant, moderate association between categorised pain score at three hours and whether or not a long-acting opioid was given (p=0.0072; Cramer's V=0.34). The percentage of patients with a severe pain score was lower for those who had been given a long-acting opioid (5 %) compared to those who had not (32 %) (Figure 6). Long-acting opioid was prescribed more commonly (90 %) in consultant / PMO lead cases, however, less than half (43 %) of the consultant / PMO lead cases used long-acting opioids.

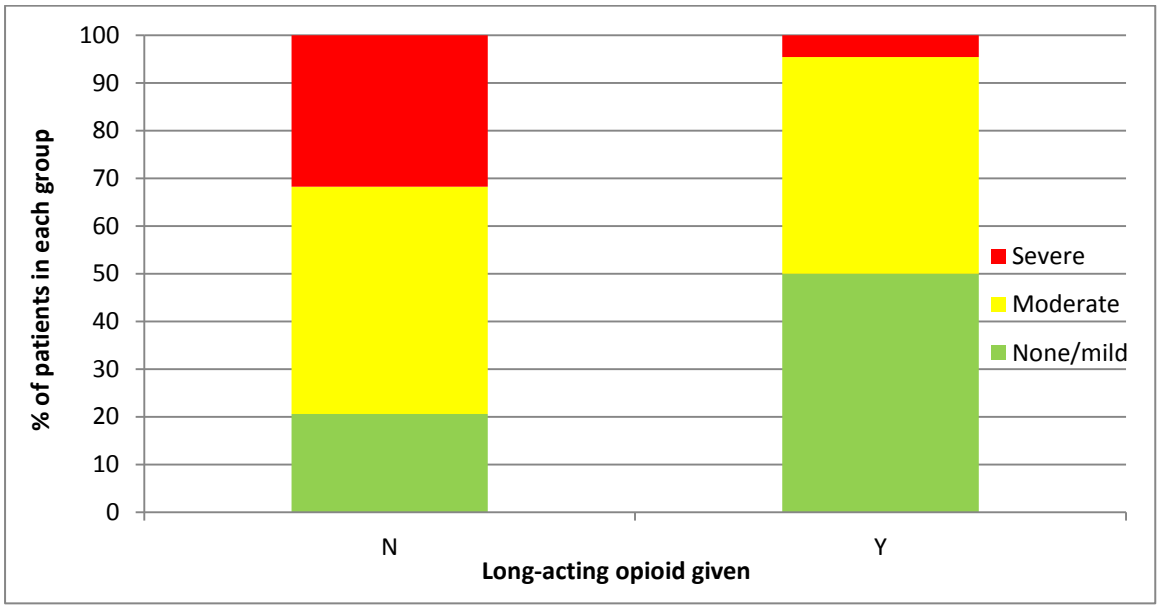

Figure 6 Comparison of categorised pain scores at 3 hrs and usage of long-acting opioid.
N = given fentanyl / equivalent only; Y = given fentanyl / equivalent and morphine or tramadol

There was a significant, moderate association between categorised pain score at first verbalisation and surgical rank (p=0.0027; phi coefficient=0.46). The percentage of patients with a severe pain score was lower for consultants (55%) compared to registrars or MOs (84 and 75% respectively) (Figure 7). There were no significant associations between surgical rank and pain scores at other time points. Tonsil size made no significance to pain scores at any time points.

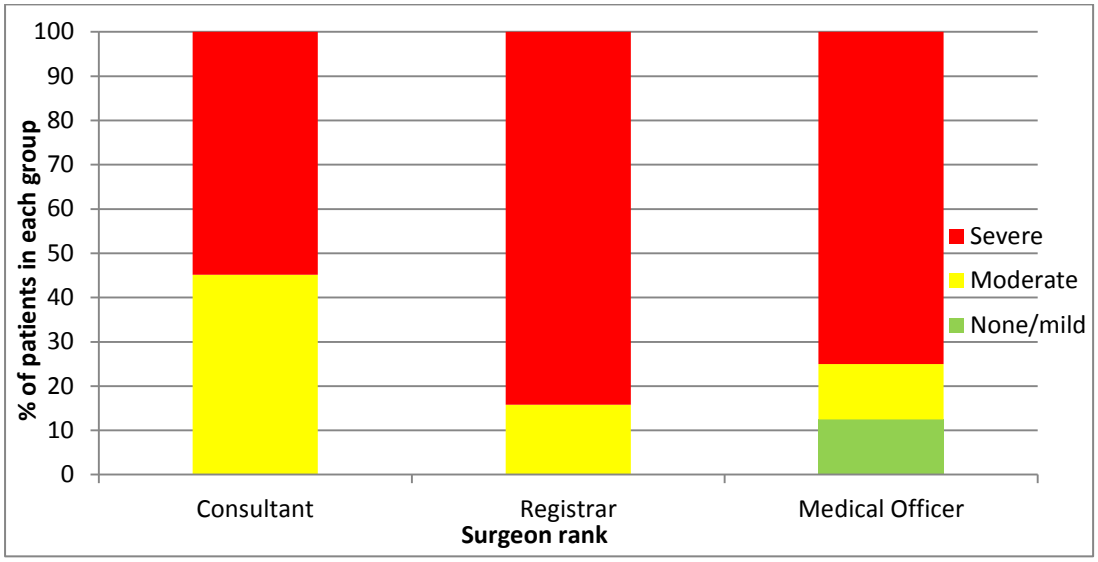

Figure 7 Comparison of categorised pain at first verbalisation and surgical rank

A significant association was found between the median duration of surgery and categorised pain score at 30 minutes (p=0.0078). Post–hoc tests showed that those with severe pain scores had longer median duration of surgery (30 min; IQR 20-40 min) than those with moderate pain scores (15 min; IQR 10-30 min) or those with no/mild pain scores (15 min; IQR 15-20 min). The effect sizes were moderate and small, respectively (r=0.30 and 0.29 respectively) (Figure 8). There were no significant associations between duration of surgery and pain scores at other time points.

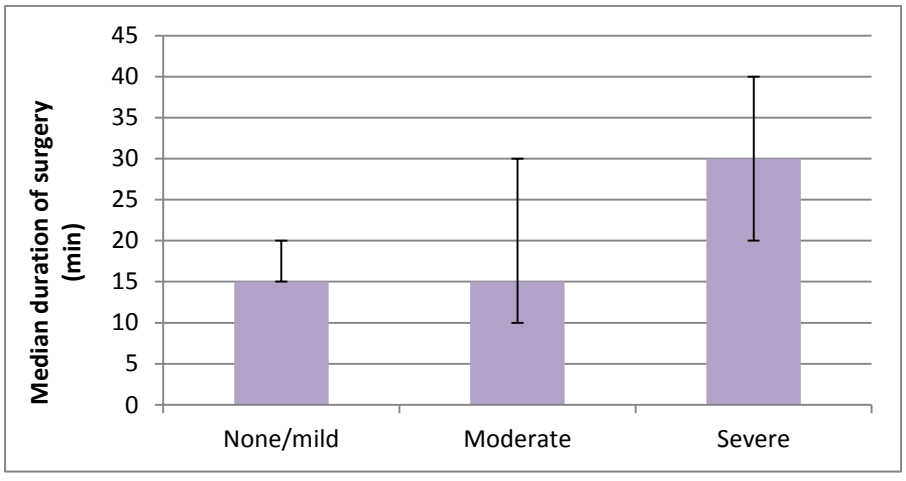

Figure 8 Comparison of median duration of surgery and categorised pain score at 30 minutes

A significant association was found between the median duration of anaesthesia and anaesthetists rank ($p<0.0001$). Post–hoc tests showed that consultants / PMOs had longer median duration of anaesthesia (60 min; IQR 45-70 min) than the senior or junior registrars (35 min; IQR 25-45 min and 30 min; IQR 30-60 min respectively) (Figure 9). The effect sizes were moderate (r=0.57 and 0.33 respectively).

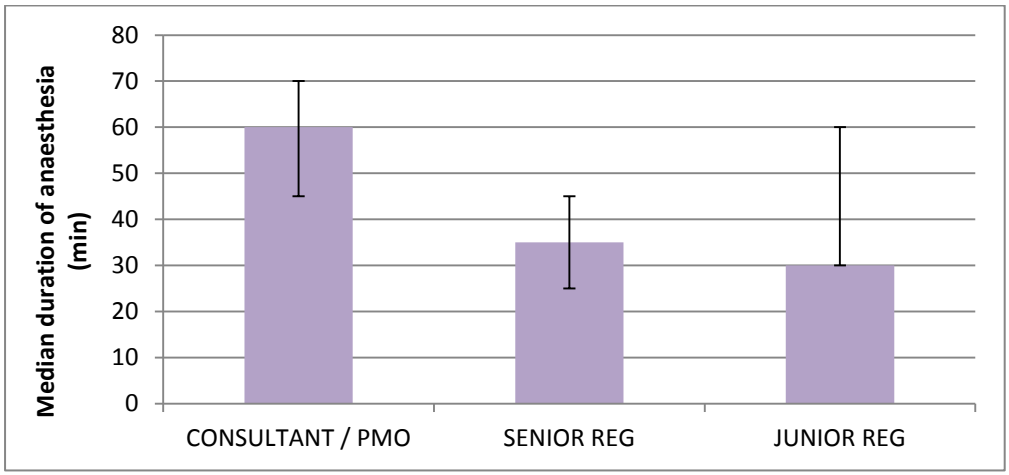

Figure 9 Comparison on duration of anaesthesia and anaesthetic rank

There was a significant association between the median duration of surgery and surgeon rank ($p<0.0001$). Post–hoc tests showed that consultants had shorter median duration of surgery (15 min; IQR 10-20 min) than the registrars or MOs (30 min; IQR 20-40 min and 30 min; IQR 15-48 min respectively). The effect sizes were moderate (r=0.60 and 0.54 respectively) (Figure 10).

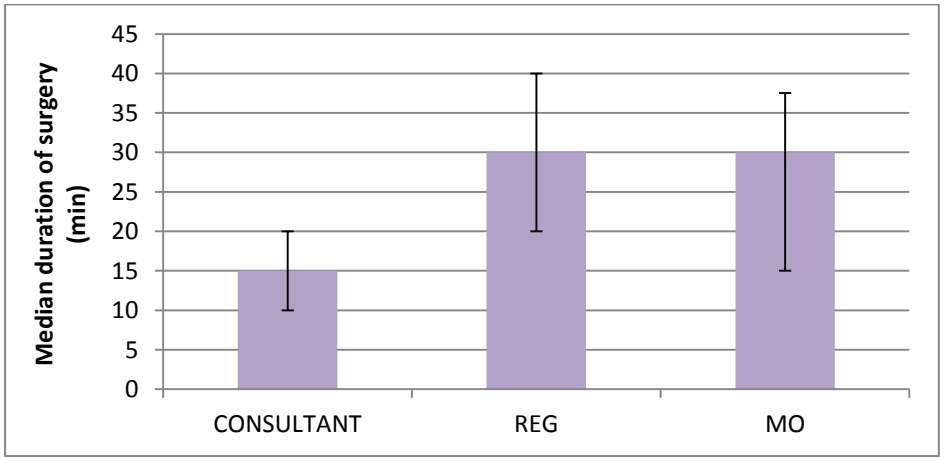

Figure 10 Comparison of duration of surgery and surgical rank

Discussion

Tonsillectomy is one of the commonest surgical procedures in children [1-4, 8]. Yet it has been identified as a procedure associated with a high incidence of severe postoperative pain. Factors that contributed to this poorly managed pain in this audit included:

- Surgical technique and duration of surgery;
- Anaesthetic technique; inability to recognise and assess pain;
- Misconceptions / preconceived ideas about analgesic drugs;
- Child and system factors.

Surgical technique

Cold steel dissection (snare) and a variable degree of monopolar electrocautery to achieve haemostasis are used at CHBAH. Bipolar cautery should be used instead of monopolar electrocautery because it results in less tissue damage and therefore less postoperative pain. It also has the benefits of reduced intraoperative bleeding and surgical time. [8, 9, 17]

In this study, surgical seniority was associated with shorter duration of surgery and lower incidences of severe pain at 30 minutes. Unfortunately, literature remains inconclusive regarding the difference of perioperative pain and varying degree of surgical experience.[18, 19] Anaesthetic seniority was associated with higher pain scores because consultants / PMO anaesthetists often operate with junior surgeons, while 'catch-up' lists run by junior anaesthetists have consultant surgeons operating.

Analgesia

Evaluation of postoperative pain is complicated by the difficulty in assessing pain in children and the occurrence of emergence delirium. It is often difficult to differentiate between the pain and ED because of the overlapping clinical picture, and because pain can often be the cause of agitation.[14] Furthermore, several studies have shown that otorhinolaryngological procedures, sevoflurane, and also preoperative anxiety increase the risk of emergence delirium.[14, 15, 20] To overcome this, pain assessment took place at multiple points and a self-report scale was used. The Wong-Baker scale, which was chosen, can be used in children as young as three, and is available in various local translations.[21]

In this audit, analgesic drugs used included short acting opioid usually in the form of fentanyl (at a median dose of 1.8 ug/kg); dexamethasone (0.1 mg/kg) and paracetamol (15mg/kg). Lack of administration of these three was found to be due to unavailability. The use of NSAIDs perioperatively in adenotonsillectomy has been encouraged as they are opioid-sparing, reduce PONV and time to first oral intake.[22, 23] However, concerns seemed to exist about ketamine and long-acting opioids.

There is reluctance for practitioners to give long acting opiates in children presenting for tonsillectomy. Only 25 % of the study population received morphine or tramadol. This is due to fear of opioid associated side effects (e.g. sedation, respiratory depression, PONV, anoxia and death); pharyngeal surgery in children who are at a high risk of airway reactivity; and unpredictable postoperative monitoring. Interestingly, long-acting opioids were commonly prescribed (90 %) in consultant / PMO lead cases resulting in improved pain scores at discharge from recovery (severe pain in 2 % consultant lead vs 29 % junior registrar lists). Three hours postoperative, severe pain was better in patients who had received long acting opioids versus those who had not (5 % versus 32 % respectively). This is due to individual drug pharmacokinetics. Literature on tramadol usage and adverse effects in children presenting for tonsillectomy is limited. Accurate risk-benefit analysis is thus not available [24], and until such time the routine usage of tramadol cannot be recommended.

Recommendations are a multimodal combination of individually titrated intraoperative opioids (morphine 0.1 mg/kg or tramadol 1 mg/kg to be considered), dexamethasone, and regularly administered mild analgesics in the form of paracetamol and/or NSAIDs. Ketamine ($\leq$ 0.5 mg/kg) improves analgesia but its advantage must be carefully considered when administered with morphine. Dexmedetomidine (1ug/kg) or clonidine reduces opioid requirements and agitation especially in children with sleep disordered breathing, and is advised.[13, 25] Growing fears of opioids may eventually lead us to consider the usage of gabapentinoids, honey and non-pharmacological measures.

Child and system factors

Despite the stringent recommendations of the American Society of Anaesthetists [26], children in this study were routinely faced with 13.2 (minimum 10.3 and maximum 18.5) hours without eating or drinking. Appropriate fasting and adequate intra-operative hydration (10 -15 ml/kg) has been shown to reduce the incidence of PONV, anxiety, agitation, dehydration, and in some studies has been associated with a decrease in pain.[27, 28]

Ninety four percent of parents questioned were satisfied with the process, while six percent were not satisfied. Reasons given included: lack of communication, no knowledge of the process, prolonged theatre time without notification of wellbeing of child, long fasting times and pain postoperatively.

Shortage of staff and equipment contributes to several deficits in the delivery of both surgical and anaesthetic services at CHBAH. These 'system factors' can be improved by:

- Communication amongst all role players.
- Increase in functional equipment and monitoring would foster better premedicating and analgesic practices
- Shortening the hospital stay would have socio-economic benefits, and possibly encourage greater parental presence. Currently patients are admitted for ≥ 48 hours.

Limitations

This study is contextual to Chris Hani Baragwanath Academic Hospital, and the results cannot be generalised to other hospital in Johannesburg or in South Africa. A great deal of the practice is influenced by system errors which may not adhere to established norms. However, the findings in this study are in keeping with multiple studies in first world countries, and confirm the dilemma experienced in managing paediatric pain.
Response bias is a further potential limitation, not only for children being assessed, but also for anaesthetists who may change practice due to the presence of an auditor.
An analysis of pain categorised further into mild, moderate and severe; and associations with selected variables was included. In order to detect a medium effect size (if it exists), with 80 % power, at the 5 % significance level; a sample size of a minimum 108 patients was required. Only larger effect sizes (if they exist) could be detected with such a small sample size. This is a limitation in the study.

Conclusion

Audits are necessary to evaluate what resources are needed to optimise care.[19] Despite the vast amount of literature available, perioperative pain management in patients presenting for tonsillectomy continues to be poorly managed. Appropriate premedication and two hours of clear liquid ingestion needs to be introduced. Where possible surgical technique should involve bipolar cautery and limited to less than 45 minutes, and a preemptive, multimodal, opioid-sparing anaesthetic should be routinely practiced.

Acknowledgements

This study was in fulfilment of the requirements for the degree of Master of Medicine in the branch of Anaesthesiology.

Conflict of interest

I declare that I have no financial or personal relationship(s) which may have inappropriately influenced me in compiling this paper.

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SECTION 4: Appendices

Appendix 1 – Postgraduate Approval

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

21 February 2017
Person No: 9504042N
PAG

Dr PN Mogane
P.O. Box 3993
Halfway House
Midrand
1685
South Africa

Dear Dr Mogane

Master of Medicine: Approval of Title

We have pleasure in advising that your proposal entitled *Audit of peri-operative pain management in paediatric patients following tonsillectomy at a tertiary hospital in Johannesburg* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

Appendix 2 – Ethics Approval

R14/49 Dr Palesa Mogane

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)

CLEARANCE CERTIFICATE NO. M141109

NAME: (Principal Investigator)	Dr Palesa Mogane
DEPARTMENT:	Anaesthesiology Chris Hani Baragwanath Academic Hospital
PROJECT TITLE:	Audit of Peri-operative Pain Management in Paediatric Patients Following Tonsillectomy at a Tertiary Hospital in Johannesburg (Title changed 08/07/2015)
DATE CONSIDERED:	28/11/2014
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr Mdu Mashinini
APPROVED BY:	Professor P Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	10/06/2015

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Secretary in Room 10004, 10th floor, Senate House, University.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to resubmit the application to the Committee. **I agree to submit a yearly progress report**.

Principal Investigator Signature Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

Appendix 3 – Turnitin Report

Turnitin4.docx

ORIGINALITY REPORT

%15	%9	%12	%5
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Witwatersrand Student Paper	%2
2	oto.sagepub.com Internet Source	%1
3	BABITA GHAI. "Postoperative pain assessment in preverbal children and children with cognitive impairment", Pediatric Anesthesia, 3/18/2008 Publication	%1
4	Brand, Katherine, and Benjamin Thorpe. "Pain assessment in children", Anaesthesia & intensive care medicine, 2016. Publication	%1
5	almacen-gpc.dynalias.org Internet Source	<%1
6	www.apagbi.org.uk Internet Source	<%1
7	MICHELLE C. WHITE. "An evaluation of pain and postoperative nausea and vomiting following the introduction of guidelines for tonsillectomy", Pediatric Anesthesia, 8/2005	<%1

SECTION 5: Proposal

Audit of peri-operative pain management in paediatric patients following tonsillectomy at a tertiary hospital in Johannesburg

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Department of Anaesthesiology

Co-supervisor: Professor Christina Lundgren
Department of Anaesthesiology

5.1 Introduction

Adeno-tonsillectomy is one of the commonest procedures performed in children(1). Poor pain control, postoperative vomiting (POV) and emergence delirium (ED) still continue to be common complications. This is despite improvements in anaesthetic and surgical technique. Severe pain is reported in 25 – 50 % of children(2), and has frequently been treated with opioids resulting in a higher occurrence of postoperative nausea and vomiting (PONV) compared with other forms of analgesia. Emergence delirium is also a frequent postoperative complication in young children undergoing otorhinolaryngology procedures, and is worsened by sevoflurane anaesthesia(3) and the difficulty in differentiation from the features of postoperative pain. Currently, there exists no pre-set protocol on the anaesthetic management of patients presenting for tonsillectomy at Chris Hani Baragwanath Academic Hospital (CHBAH). It is the author's belief that a review of strategies currently employed would assist to outline the benefits or detriment of the wide variability of drug regimes used. Patient and parent satisfaction will also be assessed. Thereafter the aim is to make recommendations towards improving anaesthetic care of any child who presents for a tonsillectomy.

The International Association for the Study of Pain defines pain as "an unpleasant sensory and emotional experience associated with actual or potential tissue damage"(4). Pain is a complicated physiological process that has been difficult to assess and manage in the paediatric population even without the consequent fears of respiratory depression and sedation. Pain intensity varies with the site of the surgery, type of surgery, time of day, age, cultural background and psychological makeup of the child. Postoperative pain usually occurs within the first 24 to 36 hours(5). It may lead to untoward systemic events such as cardiovascular, pulmonary, thrombo-embolic or gastrointestinal complications(5). Furthermore, it can increase morbidity such as vomiting, behavioural changes, sleep disturbance and poor oral intake. This results in prolonged hospitalisation, and may thus impact on the economic constraints currently experienced in provincial hospitals. As a result by optimally controlling surgical pain, there is overall improvement in patient outcomes and satisfaction.

The incidence of pain post tonsillectomy at Chris Hani Baragwanath Academic hospital (CHBAH) is unknown. Some of the reasons are; the difficulty of assessment due to a lack of staff to attend each patient, the lack of usage of appropriate Pain Assessment Tools or Scales, and the occurrence of emergence delirium. Emergence delirium may thus be difficult to differentiate from pain. Pain assessment is imperative for optimal pain management. This allows for planning of appropriate interventions and the evaluation of effectiveness. Regular assessment and measurement improves pain management and increases patient, parent and staff satisfaction.

Many tools are available for the assessment of pain in children of variable ages, in different stages of development, and under a variety of circumstances (e.g. procedural or postoperative pain, research or clinical setting). However, most are neither validated, applicable to all age groups or universally accepted. In general there are physiological measures, observational (behavioural) measures and self-report (6, 7).

Physiological measures

Pain in children can be assessed via physiological parameters. These include changes in heart rate, blood pressure, intracranial pressure, cerebral blood flow, palmar sweating, respiratory rate; and also decrease in oxygen saturation and vagal tone. They serve as useful surrogate measures of pain. However many associated clinical conditions such as sepsis, anxiety, hypoxemia, hypotension and fever present with the same features(6) . These may be unrelated to the pain.

Behavioural measures

There are a series of behavioural responses seen in children that occur due to pain. These include crying, grimacing, movement of the trunk and limbs, inconsolability and changes in sleep state. This can be a substitute measure of pain. However, sensitivity and specificity is poor as other conditions can cause these features. Behavioural features that may indicate the need for analgesia in infants and young children in the peri-operative period are; position of joints and legs, motor restlessness, changes in facial expression, and crying(6).

Composite measures

A potentially comprehensive measure of pain is to incorporate physiological and behavioural features. Examples of these scales are the:

- COMFORT scale
- CHEOPS (Children Hospital of Eastern Ontario Pain scale)
- FLACC (face, leg, activity, cry, consolability) scale
- OPs (objective pain scale)

No scale is universally adopted or clearly superior to any of the others.

Table 5.1 Pain assessment tools for preschool children (6)

SCALE	AGE GROUP	INDICATORS	SCORE	COMMENTS	TIME FOR ASSESSMENT
COMFORT scale	0 – 3 yrs.	6 behavioural items (alertness, calmness, muscle tone, movement, facial tension, crying) 2 physiological items (heart rate and mean arterial pressure)	Ranges from 8 – 40	Assesses distress in ICU children up to 2 yrs. and post-operative pain up to 3 yrs.	2 minutes
CHEOPS scale	1 – 7 yrs	6 pain behaviour items (cry, facial and verbal expression, torso position, touch, leg position)	Total score ranges from 4 – 13 (cut-off point of 6 yields highest agreement with clinical decision to treat pain)	High correlation with observer and nurses VAS scores. Excellent reliability and acceptable validity	Child's response is observed for 5 seconds, followed by 25 seconds period of recording
FLACC scale	2/12 – 7 yrs	Five categories (facial expression, leg movement, activity, cry, consolability)	Ranges from 0 – 10. Score ≥ 3 represents pain	Moderate to good concurrent validity with OPS and CHEOPs.	Patient's behaviour observed for 1 – 5 min and score assigned
OPS scale	18/12 – 12 yrs	6 items (blood pressure, crying, movement, agitation, posture, complains of pain where appropriate)		Modified OPS has shown excellent reliability, construct, content & validity	30 – 60 seconds

Self-report

Self-report which is often possible in children of four years of age and above, is seen as the ‘golden standard’. It is not applicable to children who are preverbal or those with cognitive disabilities, and is dependent on the emotional and cognitive maturity of the child. At this age, children are able to localise the site of pain and differentiate its severity. Scales that can be used if properly explained include:

- Numerical rating scales
- Faces scales e.g. Wong Baker faces scale
- Visual analogue scales

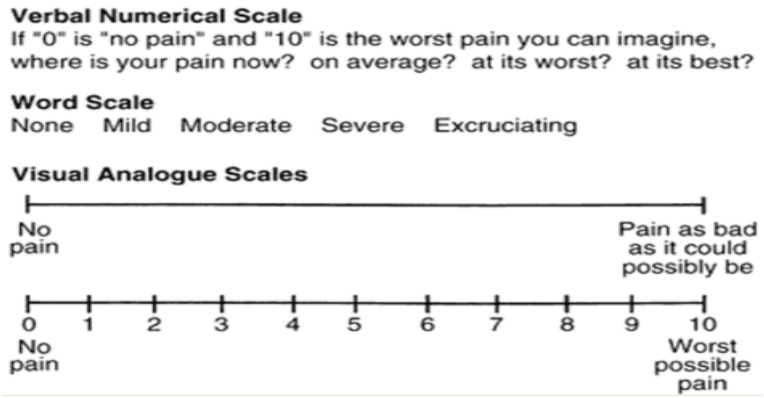

Figure 5.1 Comparison of Numeric and Visual Analogue Scales

Figure 5.2 An example of Faces Scales (7)

It is postulated that tonsillectomy pain is due to a combination of nerve irritation caused by inflammation, and pharyngeal muscle spasms (8). Multiple interventions have been suggested to minimise or eliminate the factors that contribute to this

phenomenon. Various surgical techniques have been developed. The snare dissection has been compared with electrocautery (8). Electrocautery causes more pain, due to the thermal damage of adjacent tissue, than snare dissection used alone. A multimodal approach to analgesics can also be employed. Opioids deliver good analgesic control and a decreased incidence of emergence delirium in children presenting for adeno-tonsillectomy. However, they may also contribute to sedation, nausea and vomiting, resulting in delayed discharge from the hospital. Tramadol has negligible effect on respiration in comparison to traditional opioids. For this reason it has been explored in the relief of post-tonsillectomy pain. Its efficacy in this role is well documented (9). The mechanism of action of paracetamol, a non-opioid, is not fully understood. It is proposed that it provides its analgesic action via a poorly understood serotonergic mechanism and anti-inflammatory / antipyretic action via the inhibition of cyclooxygenase-3. Another possibility is that it regulates the endogenous cannabinoid system.

Much controversy exists over NSAIDs and their contribution to bleeding in paediatric tonsillectomy. Thus far there is no data proving that the usage of NSAIDs is associated with a statistically significant increase in haemorrhage that necessitates further surgical intervention (10) except with ketorolac. Dexamethasone therapy has been associated with a reduction in emesis, an earlier desire to start feeding, and a reduction in pain (11). This clinical finding of pain reduction must however be interpreted with caution. Ketamine, a potent non-competitive antagonist of NMDA, at sub anaesthetic dosages has been shown to be opioid-sparing, leading to fewer side effects.

Otorhinolaryngological procedures in children, aged two to five years of age, are at risk of emergence delirium. This is a “dissociative state of consciousness in which the child is irritable, uncompromising, uncooperative , incoherent and inconsolably crying, moaning, kicking or thrashing”(12). It usually occurs in the first 15 minutes after awakening. This is an important problem in the recovery room as it may lead, along with injury to the child, to bleeding from the surgical site, and accidental removal of intravenous catheters and drains. Once it occurs, additional nursing care is required, as well as the administration of a sedative and / or analgesia agent. This may be associated with depression of respiration or potential airway obstruction, and

will often delay patient discharge. The use of behavioural scales for the evaluation of ED and pain may not assist in making the distinction upon awakening. Self-report scales may thus be the best tool of evaluation. The Wong-Baker FACES pain rating scale is recommended for usage in children three years of age and older.

5.2 Problem statement

Members of the department of anaesthesia at the Chris Hani Baragwanath Academic Hospital, anaesthetise children presenting for a tonsillectomy using different methods. The standard method usually includes an inhalational induction with sevoflurane and thereafter the administration of a variety of intravenous agents. These may include: simple analgesics (paracetamol and non-steroidal anti-inflammatory agents); opioids - which may be anything from a short acting agent like alfentanyl to long acting agents like morphine, pethidine or tramadol; ketamine at a variety of dosages; and dexamethasone. With such a wide variety of medications, one questions whether the patient's analgesic requirements are met. This situation is often assessed by physiological measures. This may result in the potential of ignored pain due to the confusion to differentiation from emergence delirium, hunger, haemorrhage, etc. The consequence is poor patient and parent satisfaction, agitated nursing staff, and the potential for unnecessary or incorrect drug administration.

5.3 Aim

The purpose of this study is to assess analgesic management by reviewing both drugs administered intra-operatively and medications prescribed post-operatively. The effectiveness will be objectively viewed using internationally accepted scale / tools.

5.4 Study objectives

Postoperative pain management and the avoidance of emergence delirium remain major challenges in the care of tonsillectomy patients. Despite advances made in our

knowledge, there is still inadequate treatment in children. This study of current practices at Chris Hani Baragwanath Academic Hospital will examine current strategies employed, and will facilitate the development of new practical recommendations aimed at improving peri-operative management of the paediatric patient presenting for tonsillectomy.

Primary objectives of the study are:

- To describe current analgesic strategies employed in patients presenting for tonsillectomy by reviewing anaesthetic and surgical techniques and prescription
- To assess the severity of post-operative pain in the children presenting for this procedure

Secondary objectives of the study are:

- To assess parental satisfaction with these strategies
- To propose a pain management plan for children presenting for tonsillectomy

5.5 Research assumptions

The following definitions will be used in the study

Anaesthetist: is a doctor who has qualified with a recognised medical board, working in the Department of Anaesthesiology. This includes medical officers, registrars and consultants.

Junior registrar (in Anaesthesia): is an anaesthetist who has not yet written and passed their part one college examinations in Anaesthesiology.

Senior registrar (in Anaesthesia): is an anaesthetist who has passed their part one college exams, but has not yet written and passed their part two college examinations in Anaesthesiology.

Consultant (in Anaesthesia): is a specialist anaesthesiologist who has completed all criteria and passed the required South African College of Medicine examinations,

or equivalent. Medical officers with more than 10 years of experience are career medical officers and are regarded as consultants

Ear Nose Throat (ENT) surgeon: is a doctor who has qualified with a recognised medical board, working in the Department of Otorhinolaryngology. This includes medical officers, registrars and consultants.

Medical officer (in ENT): is a qualified doctor working in the Department of Otorhinolaryngology under specialist supervision.

Registrar (in ENT): is a qualified doctor training under specialist supervision. They will have completed their part one and intermediate examinations in Otorhinolaryngology.

Consultant (in ENT): is a specialist surgeon in Otorhinolaryngology who has completed all criteria and passed the required South African College of Medicine examinations, or equivalent.

Mild pain: Pain score on the Wong Baker scale of two.

Moderate pain: Pain score on the Wong Baker scale between four and six.

Severe pain: Pain score on the Wong Baker scale between eight and 10.

5.6 Demarcation of study field

The study will take place at the Chris Hani Baragwanath Academic Hospital (CHBAH), Johannesburg, Gauteng Province. It is the biggest hospital in South Africa with 408 paediatric beds, excluding surgical beds. It serves as a referral centre for many surrounding regional hospitals.

5.7 Ethical considerations

Ethical approval for the study will be sought from the Human Research Ethics Committee (Medical) of the University of Witwatersrand, the Postgraduate committee, and the Chief Executive Officer (CEO) of CHBAH. Approval will also be sought from the Heads of Departments of ENT (Ear, Nose and Throat) and Anaesthesia at CHBAH. A comprehensive information letter and clear explanation of the study will be given to the parents or legal guardians of all participants; and written consent will be to participate in the study will be mandatory.

The study will adhere to the principles of the Declaration of Helsinki 2013 and the South African Good Clinical Practice Guidelines.

5.8 Research methodology

5.8.1 Research design

A prospective, contextual, descriptive research design will be used(13).

PROSPECTIVE – in prospective studies, variables occur during the course of the study whereas in retrospective studies variables have already occurred when the study takes place. The study will assess analgesics used peri-operatively, and measure incidences of pain post-operatively.
CONTEXTUAL – this study will only be conducted at the Chris Hani Baragwanath Academic Hospital (CHBAH).
DESCRIPTIVE – descriptive designs focus on measurable aspects of human behaviour and provide a picture of a phenomenon as it naturally occurs.

5.8.2 Study population

The study population will be ASA I and II patients aged 3 – 12 years who are scheduled for elective tonsillectomy at CHBAH.

5.8.3 Study sample

Sample statement and method

In consultation with a biostatician, an appropriate sample size has been calculated and an appropriate sampling method employed. A sample size of 62 – 82 patients would be ideal.

Inclusion criteria

All ASA I and II paediatric patients aged between 3 and 12 years of age presenting for elective tonsillectomy at CHBAH under general anaesthesia.

Exclusion criteria

The following patients will be excluded from the study:
- emergency surgery
- ASA III - V, presence of confirmed genetic or metabolic syndrome
- children with behavioural disorders / cognitive impairment
- a history of chronic pain or use of analgesic drugs
- any requiring pre-operative sedation or TIVA
- any in who consent cannot be obtained
- participants in whom it is not possible to use study scales

5.9 Description of data collection

Permission will be obtained from the Postgraduate Committee, University of Witwatersrand Ethics Committee and from the Chief Executive Officer at the Chris Hani Baragwanath Academic Hospital.

Potential participants will be identified and an invitation extended to the parents or legal guardian. An information letter and explanation of the study will be given and informed consent requested. A thorough history and physical examination will be

performed (ideally in the ward) to ensure the participants has all the required criteria in order to be included in the study. Use of a translator will be made if there is any language barrier.

The anaesthetic plan will continue as required by the attending anaesthetic consultant / registrar. Once surgery has been safely concluded, the patient will be transported from the operating room. The patient must be breathing spontaneously and also extubated prior to admission to the post-operative care unit (PACU). The following data will then be collected and entered onto a data capture sheet:

- patient demographics (age and gender)
- weight
- ASA classification
- duration of surgery (the assumption being that this may give an indication of tonsillectomy difficulty); surgeon experience will be noted
- peri-operative complications e.g. difficult airway, laryngo- or bronchospasm, delayed awakening
- time spent in PACU
- complications in PACU
- age appropriate pain scores
- post-operative course (to include complications, analgesic requirements in ward)
- time when discharged home

This data will be collected by the investigator. A single investigator has been used in order to standardise the recording mechanism used i.e. assessment tools, and the questionnaire completed.

5.10 Data analysis

Data will be captured on an Excel® spreadsheet and analysed with Stastica® 12.0. Results will be summarised as mean and standard deviation or median and interquartile range for ordinal data or non-normal distributed. Ninety five percent confidence intervals will be calculated for all variables. Significance will be set at a $p < 0,05$.

5.11 Significance of study

The study aims to review the potential strategies, in the prevention and / or management of peri-operative pain, employed by anaesthetists during tonsillectomies at CHBAH. It will highlight the necessity for the usage of validated scales / scores for the presence of pain and delirium in the paediatric population. This in turn will enable practical recommendations. It may also establish a protocol, aimed towards improved management practices particular to the population serviced at CHBAH.

5.12 Validity and reliability

The validity of any study is the extent to which it reflects the characteristics being measured. The reliability of a study refers to the consistency of the measures implemented in the study.

Validity and reliability of the study will be ensured by:

- appropriate study design
- representative study sample
- data analysis being done in consultation with a biostatistician.

Validity and reliability of the questionnaire will be ensured by:

- conducting an extensive literature review prior to developing the questionnaire
- an anaesthetic colleague assessing the questionnaire for face and content validity.

Threats to the validity and reliability include:

- the contextual nature of the study means that the results cannot be generalized to other hospitals in South Africa. The study only provides insight to the situation at CHBAH.
- the potential threat, specifically to validity, is the possibility that in anticipation of the study, attending physicians may change their usual practice.

5.13 Potential study limitations

This study will be done contextually in the Department of Anaesthesiology and the results thereof may not be generalised to other institutions. However, the study may identify knowledge gaps that can then be addressed.

5.14 Project timeline

Activity	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Protocol pre-paration	X	X													
Chapters 1, 2, 3			X	X	X										
Ethics & Postgrad Sub-mission			X	X	X	X	X								
Data collection								X	X	X	X				
Data capturing											X	X			
Data analysis												X	X		
Chapters 4,5													X	X	
Sub-mission of MMed														X	X

5.15 Financial plan

The costs involved in the study will be incurred by the researcher and will include printing at 60 cents a page.

Description	Price per item	Number of items	Total
Proposal	60c / page	30	R18
Questionnaire, consent form & information letter	60c / page	200	R120
Research report	60c / page	600	R360
Binding	R200 / copy	3	R600
Total			R1098

5.15 References

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APPENDIX 1: INFORMATION LETTER (ASSENT DOCUMENT)

Dear Parent / Caregiver

My name is Palesa Mogane. I am an Anaesthesiology consultant at Chris Hani Baragwanath Academic Hospital. I would like to invite you and your child to participate in my MMed research study about current peri-operative practices in the management of patients presenting for tonsillectomies.

Your child has been identified by the Ear Nose and Throat (ENT) doctor as needing a tonsillectomy ± adenoidectomy. He / she will need to be put to sleep for this procedure which may take 15 – 60 minutes. During this sleep my colleagues will give drugs that will help with decreasing the incidence of pain, nausea and vomiting. Once the surgeon is finished, your child will be awoken and taken to recovery, where he / she will stay for a further 30 minutes to ensure he / she is comfortable without any further complications. There will be no change to this management. Instead it is during this recovery period that we will document how long the procedure has taken, what medications were given, and how comfortable he / she is. This will help to identify what the current practices are, and also help identify any inadequacies. This in turn will allow us to formulate appropriate recommendations to improve standards.

All attempts will be made to keep you and your child's identity secret, however this cannot be guaranteed. Your participation is voluntary, and the decision to refuse to participate or to withdraw from the study at any stage will not result in any change to treatment.

The usual good standard of care that takes place at Chris Hani Baragwanath Academic Hospital will not be changed. There will be no extra cost to you. No complications are expected as a result of your participation in this study.

Thank you for your co-operation.

Dr Palesa Mogane
Department of Anaesthesia
Chris Hani Baragwanath Academic Hospital

APPENDIX 2: CONSENT FORM

RESEARCH TITLE: AUDIT OF PERI-OPERATIVE PAIN MANAGEMENT IN PAEDIATRIC PATIENTS FOLLOWING TONSILLECTOMY AT A TERTIARY HOSPITAL IN JOHANNESBURG

I ..... (parent / legal guardian), agree to participate in the above study. I understand that my child's care will not be changed or compromised due to this study. I understand that information about my child will be used in this study.

I understand the reasons for the study and my questions have been answered. I understand that I can withdraw from the study without notice and that my child will not be disadvantaged

Signed at .....

Date .....

Signature .....

APPENDIX 3: QUESTIONNAIRE (DATA COLLECTION FORM)

Patient information

Study number	
Age	
Gender	
Weight	
ASA rating	
Fasting duration	

Anaesthetic information

Surgical expertise :
Anaesthetic expertise:
Intubation attempts:

Surgical starting time:	Surgical finishing time:
Anaesthetic starting time:	Anaesthetic finishing time:

	Drug	Route	Dose	
Premedication				
Systemic drugs				

Intra-operative complications / incidences e.g. attempts at intubation, laryngospasm, bronchospasm, desaturation, difficult airway
.....
.....

Deep / Awake extubation
.....
.....

Post-operative

PAIN RATING

WONG BAKER FACES scale (> 3 yrs)

- pre-operative
- at time of first verbalisation
- discharge from recovery room (30 minutes post-operative)
- ward (3 hours post-operative)
- prior discharge

Post-operative prescription

.....
.....

Complications in the recovery and intervention required e.g. pain, nausea, vomiting, delirium, bleeding (Anaesthetic and surgical team involved will be notified and intervention carried out documented)

.....
.....

Parental satisfaction in ward	
Not satisfied	
Satisfied	
Very satisfied	

Complications in the ward and intervention required e.g. pain (document time of rescue analgesia), nausea, vomiting, delirium, bleeding

.....
.....
.....

Date and time of discharge

.....

APPENDIX 4: RESEARCH REQUEST TO CHBAH CEO

Dear ……,

My name is Palesa Mogane and I am an Anaesthesiology consultant at Chris Hani Baragwanath Academic Hospital. I would like to conduct a study entitled : AUDIT OF PERI-OPERATIVE PAIN MANAGEMENT IN PAEDIATRIC PATIENTS FOLLOWING TONSILLECTOMY (± ADENOIDECTOMY) AT THE CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL.

This study will involve the assessment of analgesic regimes employed both by the anaesthetists and surgeons for children aged 2 – 12 years presenting for tonsillectomy with or without adenoidectomy. It will be conducted predominantly in theatre and involve post-operative follow-up in the ward until time of discharge home. Once completed, this will be handed in to the Wits University Department of Health Sciences as part of my MMed degree.

The study is in the process of being reviewed by the Medical Human Research Ethics Committee (HREC) and the Post-graduate Committee of the University of the Witwatersrand. Furthermore, written assent to conduct the study will be obtained from the departments of Anaesthesia and ENT (Ear Nose and Throat).

I would like to request consent from the CHBAH management to conduct this study.

Yours sincerely.

Palesa Mogane

APPENDIX 5: LETTER OF ASSENT FROM DEPARTMENT HEADS

Dear Professor ……

My name is Palesa Mogane and I am an anaesthesiology consultant at Chris Hani Baragwanath Academic Hospital.

I would like to request your agreement to conduct a research study that will be handed in to the Wits University Department of Health Sciences as part of my MMed degree.

This study has been approved by the Human Research Ethics Committee (Medical) (Number……..). Furthermore, permission to conduct the study will be requested from the Chris Hani Baragwanath Academic Hospital Research Board.

The study hopes to assess intra-operative and post-operative analgesic prescriptions and their effectiveness in addressing pain requirements of children between the ages of 2 – 12 years presenting for tonsillectomy. The incidence of emergence delirium will also be assessed as there is a significant risk in children aged 2 -5 years of age presenting for ENT surgery. The patient will be followed up until discharge from the hospital. Data will then be reviewed objectively using internationally standardised scales, this information will then be captured on a data collection form. The hope is that this audit will allow for identification for any inefficiency in the system and that recommendations towards a protocol can be made.

I would like to request permission to conduct my study in your department.

I, ……., grant permission to Palesa Mogane to perform data collection for her MMed study on peri-operative pain management in paediatric patients following tonsillectomy (with or without adenoidectomy) at the Chris Hani Baragwanath Academic Hospital.

Signature: ……

Date: ……..