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TITLE PAGE

# Unplanned inter-hospital transfers following elective paediatric surgery in a private hospital


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ABSTRACT – 233 words

BACKGROUND: A significant number of surgeries in children are being performed in the private setting. Our aim was to determine the rate of unplanned inter-hospital transfers (IHTs) for paediatric patients undergoing elective surgical procedures in a private hospital without a paediatric intensive care unit to a tertiary hospital, and to investigate the reasons for these transfers.

METHODOLOGY: At retrospective clinical audit was performed searching hospital coded data of all patients aged 18 years or less at the date of admission, who underwent elective surgery between 1 January 2013 and 31 October 2018 at St Vincent's East Melbourne Private Hospital (SVEMPH).

RESULTS: 17,366 patients were identified, of whom 23 required IHT, an overall transfer rate of 0.13%. Adenotonsillectomy had the highest IHT rate of 0.26%, however, operative specialty had no statistical correlation with IHT ($p$ = 0.24) with a comparable transfer rate across all specialties. Hypoxia was the most frequent reason for IHT and was the cause in 16 out of 23 transfers (69%). Nine cases (39%) were transferred due to hypoxia while awake and seven (30%) due to hypoxia only while asleep. Three patients requiring IHT were identified as having preoperative acute respiratory illness.

CONCLUSION: Elective paediatric surgery undertaken at SVEMPH is safe and has a low IHT rate, with surgery involving the upper airway having a higher risk. In the paediatric population, hypoxia while awake is the most frequent cause for IHT.

MAIN TEXT (Word Count including abstract, tables and references = 3400)

# Unplanned inter-hospital transfers following elective paediatric surgery in a private hospital

## Introduction

An increasing number of elective surgeries are occurring in the private setting with 66.3% of all elective surgery in Australia between 2017 and 2018 being undertaken in private hospitals(1). Many elective paediatric operations are also performed in private hospitals, but unlike adult private hospitals, there are no private hospitals in Australia with an accredited paediatric intensive care unit(2). In the event that an unstable paediatric patient requires an escalation in their level of care, an inter-hospital transfer (IHT) to a tertiary centre is warranted. IHTs pose an increased healthcare cost (3) and are a cause of significant stress to the patient and their family(4). While private hospitals considerably lessen the demands on the public system, avoiding the need for IHT of a child following surgery in a private hospital is clearly desirable.

In Australia, no national paediatric surgery database exists and accordingly, no large-scale, multicentre analysis of paediatric surgery data has ever been undertaken. In the USA, the Kids' inpatient database enables analysis of data from large heterogeneous cohorts of patients. Despite plentiful available data, no studies to date have specifically focused on IHT as an outcome. One reason for the scarcity of IHT studies may be that a parallel private and public healthcare system where patients access care in both arenas, as exists in Australia, is not universal. As such, research and data surrounding IHT for escalation of care in surgical paediatric patients is limited and a thorough review of surgical paediatric IHTs from private hospitals would provide valuable information to both health care providers and consumers.

Appropriate patient pre-admission criteria, good clinical governance, mandatory reporting of adverse events and regular discussion and review of adverse outcomes in morbidity and mortality meetings are the mainstay of monitoring and reporting the safety of elective surgery. Whilst IHT is not the only indicator of surgical safety, it is a useful surrogate and is the focus of this paper.

Our study aims to provide a snapshot of the current rate of IHT in children undergoing elective surgical procedures in a private hospital facility who required unplanned transfer to another facility for higher acuity care for the management of medical, anaesthetic or surgical complications. In addition, this study also aims to identify the reasons for unplanned IHT.

## Methodology:

A retrospective clinical audit was carried out using a database search algorithm for patients aged 18 years or less who underwent elective surgery at St Vincent's East Melbourne Private Hospital (SVEMPH), a private general hospital with a paediatric ward, between 1 January 2013 and 31 October 2018. This search over a 70 month period yielded a cohort of 17,366 patients. SVEMPH has strict admission criteria which is presented in table 1.1(5).

A second search of hospital data was carried out using the same criteria as above with the addition of the criterion of discharge destination other than home. The second search identified a cohort of 23 patients who required postoperative transfer to other hospitals. The files of all 23 patients were reviewed to identify the clinical reason for IHT and were cross-referenced with the minutes from the morbidity and mortality meetings in which their cases were discussed. Data from the 23 transferred patient files was tabulated to assess the clinical reason for IHT.

For the purpose for this study, hypoxia is defined as having a $SpO_2$ less than 94% despite the use of supplemental oxygen and septic is defined as fever above 38$^{o}$C with one other sign; either tachycardia, increased work of breathing or wheeze. In cases where a patient was both septic and hypoxic, the reason of hypoxia was used.

Due to the low event rate, no meaningful statistical analysis could be undertaken between the two cohorts. Pearson Chi-Square analysis was used to test for association between factors within the IHT group of 23 patients (statistical significance where $p < 0.05$). This study was approved by the St Vincent's Human Research Ethics Committee before commencement of data collection.

**Results**

There were 17,366 (10,081 male, 7284 female, 1 not recorded) patients who had undergone elective paediatric surgery, with a median age of 5 years (*SD* = 4.7). Of those, 23 patients (16 male, 7 female) with a median age was 2 years (*SD* = 3.9) required unplanned IHT to a higher acuity centre. The overall transfer rate was for all procedures was 0.13%.

ENT surgery comprised 12,382 (71.3%) of the total volume of cases. Sixteen (69%) of the unplanned IHTs occurred in this group, representing an unplanned IHT rate following ENT surgery of 0.13%, the same as the overall IHT rate. A breakdown of total number of procedures and IHT rate for each surgical subspecialty is listed in table 1.2.

The ten most common individual operations performed are listed in table 1.3 with the most frequent being adenotonsillectomy, bilateral myringotomy with tympanostomy tube insertion, adenoidectomy alone, tonsillectomy alone and male circumcision. These comprise over half of all operative cases identified in the period of review.

All surgical procedure where IHT was required are listed in table 1.4.Tonsillectomy with adenoidectomy was the most common procedure and has an IHT rate of 0.26%, double the average rate.

For the 23 patients who underwent IHT, 20 were transferred to the Royal Children's Hospital, two to Monash Children's and one to St Vincent's Fitzroy Private high dependency unit. 19 required supplemental oxygen via nasal prongs or face mask for transport, two were intubated and two required no additional support.

Two patients were transferred directly from the operating theatre, 9 from the recovery room and 12 from the ward. Of the 12 patients who were transferred from the ward, seven were transferred greater than 24 hours post operatively. The details are

summarised in Table 1.5, with respect to the reason for IHT, the location of the patient at the time of IHT and the time following completion of surgery when IHT was required.

Decision for IHT was taken by either the treating surgeon or by the anaesthetist. Hypoxia was the most frequent reason for IHT and was the cause in 16 out of 23 transfers (69%). Nine cases (39%) were transferred due to hypoxia while awake and seven (30%) due to hypoxia only while asleep. In the seven cases of hypoxia while asleep, there was also a second factor influencing IHT such as increased work of breathing (n = 3) concurrent fever (n = 2), wheeze (n = 1) or nursing staff unable to record oximetry while the patient was awake (n = 1).

In the case of the patient who was unresponsive, the cause was determined to be residual anaesthetic agent in their peripheral cannula that was flushed on the ward. The patient with bradypnoea was a 3 year old male with a respiratory rate of 10 breaths per minute with normal oximetry. This was the only case out of the 23 patients who underwent IHT where there was a note in the medical record stating that the surgeon and the anaesthetist considered the transfer unnecessary. Only three patients requiring IHT were identified as having preoperative acute respiratory illness.

Pearson Chi-Square analysis of variables in the cohort who underwent IHT shows an association between the type of surgery and reason for IHT ($p = 0.015$). The standardised adjusted residuals revealed that, for patients who underwent adenotonsillectomy or adenoidectomy alone, the reason for IHT was more likely to be hypoxia than expected under independence (Standardised adjusted residual = 2.4).

There were no significant associations between age ($p = 0.13$), comorbidities ($p = 0.68$) or operative specialty ($p = 0.24$) and reason for IHT. There was an association between IHT within 0-6 hours postoperatively and reason for transfer other than hypoxia ($p = 0.036$). Transfers within 6 hours of operation (n=3) were less likely to be due to hypoxia but rather to a sudden complication such as laryngospasm, pneumothorax or anaphylaxis.

## Discussion

This paper sought to establish the IHT rate in patients undergoing elective paediatric surgery at a private hospital. The most striking finding is the remarkably low transfer rate. Surgeons can confidently reassure their patients in the preoperative setting that, given appropriate pre-operative clinical screening, the likelihood of unplanned IHT is low (0.13%).

Further, adenoidectomy and adenotonsillectomy were identified as carrying double the risk of unplanned IHT and had a significant association with postoperative hypoxia as the reason for IHT. Notably, there were no IHTs for patients who had a tonsillectomy without adenoidectomy. Presumably, this is a reflection of the likely clinical indication for performing a tonsillectomy alone being recurrent tonsillitis rather than obstructive sleep apnoea.

Clinical experience of postoperative adenotonsillectomy patients is replete with events of hypoxia occurring while asleep in the early post-operative period due to residual sleep apnoea or to the lingering effects of anaesthesia causing hypoventilation. While

hypoxia generally resolves when the patient is woken, a number of cases that required IHT had a degree of hypoxia that persisted while awake or, displayed other concerning factors such as drowsiness, increased work of breathing, fever or symptoms of upper respiratory tract infection. While undergoing upper airway surgery increases the likelihood of postoperative hypoxia, it is reassuring that the absolute risk is still low (0.23%).

The results of this study are in line with clinical experience of postoperative IHTs. Transfers from the operating theatre or within the first 6 hours tend to be for unexpected, sudden complications that are direct sequelae of the anaesthetic or operation. IHTs from the recovery room or from the ward, more than 6 hours after surgery, tended to be due to hypoxia with or without additional factors such as increased work of breathing, fevers, wheeze or unmeasurable oximetry and tended to occur after an initial attempt at management was made.

This study is limited by a low event rate. With only 23 patients over 70 months, the data does not lend itself to comparison with the large cohort of patients who did not undergo IHT.

Whilst the low IHT rate identified in this study is impressive, some caution should be exercised in generalising results to other institutions, as our results may be reflective of the SVEMPH admission criteria for surgery in children and the quality of the institution, medical, nursing and support staff. However, this study does serve as a useful benchmark for other centres carrying out paediatric surgery.

We expect the findings of this study to influence the clinical practice of pre-operative counselling in SVEMPH where surgeons can now quote a percentage risk of IHT to parents of patients considering elective paediatric surgery.

## Conclusion

Unplanned IHT transfer in paediatric surgery is an uncommon event with a rate of 0.13% overall. Upper airway surgery marginally increases the risk of IHT but the absolute risk is low with the highest rate being 0.23% for adenotonsillectomy. Further research and reporting of adverse outcomes in elective paedatric surgery in Australasian population is indicated.

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TABLES (5 tables = 1250)

| Table 1.1 Admission criteria to St Vincent's East Melbourne Private Hospital | |
|---|---|
| Age | Greater than 28 days |
| ASA† score | 1 or 2 |
| Special Considerations | Tonsillectomies only performed if 2 years or older, and weighing more than 10kg.<br>Adenoidectomies only performed if 9 months or older. |
| Current Illness | Acute respiratory illness or infective gastro-intestinal disorders will not be managed at SVEMPH. |
| Exceptions | Any exceptions to the above admission criteria will be considered by the CEO / Director of Nursing and Medical Director, on a case by case basis. |

†*American Society of Anesthesiologists preoperative fitness classification*

| Table 1.2 Number of unplanned interhospital transfers (IHT) per specialty | | | | |
|---|---|---|---|---|
| Specialty | No. of procedures (percent of total) | No. of IHTs | Rate of transfer per specialty per 10, 000 (percentage) | |
| ENT Surgery | 12,382 (71.30%) | 17 | | 13/10,000 (0.13%) |
| Orthopaedics | 1920 (11.06%) | 3 | | 16/10,000 (0.16%) |
| Paediatrics/General Surgery | 1477 (8.51%) | 2 | | 14/10,000 (0.14%) |
| Plastics & Reconstructive Surgery | 842 (4.85%) | 1 | | 12/10,000 (0.12%) |
| Ophthalmology | 495 (2.9%) | 0 | | 0/10,000 (0%) |
| Hand Surgery | 224 (1.29%) | 0 | | 0/10,000 (0%) |
| Urology | 11 (0.06%) | 0 | | 0/10,000 (0%) |
| Breast and Endocrine Surgery | 8 (0.05%) | 0 | | 0/10,000 (0%) |
| Neurosurgery | 4 (0.02%) | 0 | | 0/10,000 (0%) |
| Gynaecology | 2 (0.01%) | 0 | | 0/10,000 (0%) |
| Obstetrics | 1 (0.01%) | 0 | | 0/10,000 (0%) |
| Total | 17,366 (100%) | 23 | Overall IHT rate | 13/10,000(0.13%) |

| Table 1.3 Ten most common procedures | |
|---|---|
| Type of operation | Frequency (percent of total procedures) |
| Tonsillectomy With Adenoidectomy | 5132 (29.6%) |
| Myringotomy With Insertion Of Tube Bilateral | 3489 (20.1%) |
| Adenoidectomy Without Tonsillectomy | 1609 (9.2%) |
| Tonsillectomy Without Adenoidectomy | 771 (4.4%) |
| Male Circumcision | 453 (2.6%) |
| Strabismus Procedure Involving 1 Or 2 Muscles Both Eyes | 215 (1.2%) |
| Excision Of Lesion(S) Of Skin And Subcutaneous Tissue Of Other Site Of Head | 210 (1.2%) |
| Septoplasty | 200 (1.2%) |
| Myringotomy With Insertion Of Tube Unilateral | 180 (1.0%) |
| Orchidopexy For Undescended Testis Unilateral | 164 (0.9%) |

| Table 1.4 Procedures requiring inter-hospital transfer (IHT) | | | |
|---|---|---|---|
| Operation | Total no. operations (percent of total procedures performed) | Number of IHTs | Procedure specific IHT rate per 10,000 (percent) |
| ENT | | | |
| Tonsillectomy With Adenoidectomy | 5132 (29.55%) | 12 | 23/10,000 (0.23%) |
| Myringotomy With Insertion Of Tube Bilateral | 3489 (20.05%) | 1 | 3/10,000 (0.03%) |
| Adenoidectomy Without Tonsillectomy | 1609 (9.27%) | 3 | 19/10,000 (0.19%) |
| Excision Of Thyroglossal Cyst | 18 (0.10%) | 1 | 556/10,000 (5.56%) |
| General Surgery | | | |
| Male Circumcision | 453 (2.61%) | 1 | 22/10,000 (0.22%) |
| Repair Of Umbilical Hernia | 78 (0.45%) | 1 | 128/10,000 (1.28%) |
| Orthopaedics | | | |
| Open Reduction Of Dislocation Of Hip | 17 (0.10%) | 1 | 588/10,000 (5.88%) |
| Osteotomy Of Distal Femur | 7 (0.04%) | 1 | 1429/10,000 (14.29%) |
| EUA Arthrogram + Right Salter Osteotomy | 1 (0.01%) | 1 | N/A |
| Plastics | | | |
| Insertion Of Tissue Expander | 3 (0.02%) | 1 | 3333/10,000 (33%) |
| Total | | 23 | |

Table 1.5 Frequency of reason for unplanned interhospital transfer (IHT) per discharge location and per post operative

| | Postoperative time at which IHT occurred | | | | |
|---|---|---|---|---|---|
| Location at time of IHT | 0-6 hours | 6-12 hours | 12-24 hours | 24+ hours | Total |
| Theatre | Anaphylaxis, 1<br>Laryngospasm, 1 | | | | 2 |
| Recovery | Pneumothorax, 1 | Unresponsive, 1<br>Hypoxia while asleep, 2<br>Hypoxia while awake, 5 | | | 9 |
| Ward | | Hypoxia while asleep, 2<br>Bradypnoea, 1 | Hypoxia while asleep, 1<br>Hypoxia while awake, 1 | Septic, 2<br>Hypoxia while asleep[ǂ], 2<br>Hypoxia while awake[ǂ], 3 | 12 |
| Total | 3 | 11 | 2 | 7 | 23 |

*Note.* Cells represented as "reason for IHT, frequency"
[ǂ] These patients also met the criteria for septic