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Paediatric tracheostomy: an analysis of 40 cases

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Abstract

Tracheostomy in the paediatric patient has been associated with significant morbidity and mortality compared to that in the adult. A retrospective analysis was made of 40 patients up to the age of 12 years having tracheostomies. Upper airway obstruction made up the commonest (32 patients, or 80 per cent) indication for paediatric tracheostomy in our series where males slightly outnumbered females. The majority (31 patients, or 77.5 per cent) underwent the operation under general anaesthesia with endotracheal intubation. Thirty-four (85 per cent) patients underwent 'planned' tracheostomies and six (15 per cent) underwent 'crash' procedures. Thirteen (32.5 per cent) patients were under the age of one year when tracheostomies were performed. The maximum duration of tracheostomies was between one week to within a month and after one month to within three months; each containing 11 (27.5 per cent) patients.

Sixty-four different surgical procedures were performed on these patients in which laryngoscopy and bronchoscopy were the commonest procedures. Nine (22.5 per cent) had early post-operative and 14 (35 per cent) had late post-operative complications. Among these 40 children with tracheostomies, one (2.5 per cent) died due to a tracheostomy-related cause and 10 (25 per cent) due to the primary disease process itself. Tracheostomies performed to provide access for general anaesthesia for other surgical procedures were associated with a better prognosis.

Key words: Tracheostomy; Child; Post-operative complications

Introduction

Tracheostomy in the paediatric patient has been associated with significant morbidity and mortality (Gilmore and Mickelson, 1986). The complication rates are greater in children than in adults (Gilmore and Mickelson, 1986). Improvement in medical management resulted in prolonged survival of children with multiple abnormalities and resulted in more prolonged tracheostomies (Line *et al.*, 1986). The care of infants and children with a tracheostomy presents special problems to the family and the clinician (Wetmore *et al.*, 1982; Line *et al.*, 1986). The mortality rate of children with tracheostomies is estimated to be between 11 and 40 per cent, although the incidence of tracheostomy-related death is only between 0 to 3.4 per cent (Carter and Benjamin, 1983; Line *et al.*, 1986; Kenna *et al.*, 1987; Gianoli *et al.*, 1990; Dutton *et al.*, 1995). In this article a retrospective analysis was made of 40 paediatric tracheostomies in Melanesian children of Papua New Guinea.

Materials and methods

The Port Moresby General Hospital is the tertiary referral centre of Papua New Guinea which consists of the English speaking-half of the mainland and innumerable surrounding islands with a total population of 4.5 million. This hospital is also the teaching centre for the Medical Faculty of the University of Papua New Guinea. Established otorhinolaryngology services are available only in this hospital. Patients for both elective and emergency tracheostomies from the provincial hospitals came to us by aeroplane which is the usual mode of interprovincial transport in this country due to the presence of innumerable forests, inaccessible hilly terrains and the intervening Pacific Ocean.

During the period from the beginning of 1992 to the end of June of 1998, 40 paediatric tracheostomies were managed by the Department of Otolaryngology of the Port Moresby General Hospital. The data of the paediatric patients were obtained from the Otolaryngology Clinic and the record section of the Port Moresby General Hospital. At the time of review of the patients' records the following information was gathered: sex, age of patient at the time of tracheostomy, primary diagnosis, indication of tracheostomy, nature of the procedure, presence of pre-operative intubation, the method of intra-operative airway control, surgical steps of tracheostomy, associated endoscopy and the surgical procedure, duration of tracheostomy, mode of decannulation,

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TABLE I
DIAGNOSES OF 40 CHILDREN

Diagnosis		No. of Patient
I.	Bilateral congenital choanal atresia (n = 4 or 10 per cent)	4
II.	Nasopharynx and oropharynx lesions (n = 9 or 22.5 per cent)	
	Rhabdomyosarcoma	2
	Juvenile angiofibroma	2
	Vallecular cyst	2
	Osteogenic sarcoma	1
	Lymphoma	1
	Kaposi's sarcoma	
III.	Laryngotracheal lesions (n = 16 or 40 per cent)	
	Juvenile papilloma (one with Down's syndrome)	6
	Subglottic stenosis (one with meconium aspiration with patent ductus arteriosus with atrial septal defect with paralysed left vocal fold	3
	Laryngomalacia (one with patent ductus arteriosus with left vocal fold paralysis; another with dextrocardia with situs solitus)	2
	Laryngotracheobronchitis (one with Down's syndrome; another with post-operative Blalock-Taussig shunt in Fallot's tetralogy with left vocal fold paralysis)	2
	Tracheobronchial foreign body	2
	Ruptured epiglottic abscess	1
IV.	Neck lesions (n = 3 or 7.5 per cent)	
	Massive cystic hygroma (one with infection of the cyst)	3
V.	Jaw lesions (n = 3 or 7.5 per cent)	
	Mandibular osteomyelitis with trismus	1
	Infected mandibular dentigerous cyst with trismus	1
	Maxillary ameloblastoma	1
VI.	Miscellaneous lesions (n = 5 or 12.5 per cent)	
	Guillain-Barré syndrome	2
	Head injury	1
	Snake bite	1
	Severe burn	1

and the occurrence of complication and/or death. We divided the nature of the procedure into two categories: i) 'planned' tracheostomy was performed after appropriate arrangement of personnel and equipment were made available in the operating theatre, and ii) 'crash' tracheostomy was performed in an extremely urgent situation where there was severe respiratory distress and the airway had to be achieved as rapidly as possible by whatever means possible.

Most of the tracheostomies are performed by the otolaryngologists (consultant/registrar) in the operating room. During general anaesthesia airways were achieved usually by the endotracheal tube, or rarely by bronchoscope, or rarely cricothyrotomy followed by intubation. The essential surgical steps were as follows: i) a vertical skin incision, ii) careful dissection in the midline to the thyroid isthmus, iii) division and suturing of the isthmus, iv) placement of the stay sutures on either side of the tracheal wall, v) a vertical incision through the tracheal wall, vi) placement of the tracheostomy tube, and vii) partial closure of the skin incision. Chest radiographs were routinely obtained during the immediate post-operative period. Basic tracheostomy care consisted of humidification and frequent suctioning. In our set-up we routinely used the Portex tracheostomy tubes and all patients had a duplicate tube at their bedsides in case of complete blockage of the tracheostomy tube in situ. The patients with short-term tracheostomies remained in the hospital until decannulation. The majority of the long-term tracheostomy patients remained in the hospital as they could not afford the home tracheostomy care or had come from very remote areas. The usual decannulation routine was to remove the tracheostomy tube after the patient had tolerated plugging it for at least 24 hours. Endoscopic examination was performed before the trial of decannulation whenever it was felt necessary.

In this study (1) the duration of tracheostomy was defined as the number of days from placement of the tracheostomy tube to decannulation, death, or last follow-up date until the preparation of this manuscript, (ii) intra-operative complication was defined as that occurring while the tracheostomy was being

TABLE II
DIAGNOSES AND GESTATIONAL AGE OF SIX PREMATURE CHILDREN

Diagnosis	Gestational age	Number of patient
Bilateral congenital choanal atresia	i) 36 weeks	1
	ii) 35 weeks	1
Subglottic stenosis	34 weeks	1
Subglottic stenosis (with meconium aspiration with patent ductus arteriosus with atrial septal defect with left vocal fold paralysis)	34 weeks	1
Laryngomalacia (with patent ductus arteriosus with left vocal fold paralysis)	35 weeks	1
Laryngomalacia (with dextrocardia with situs solitus)	34 weeks	1

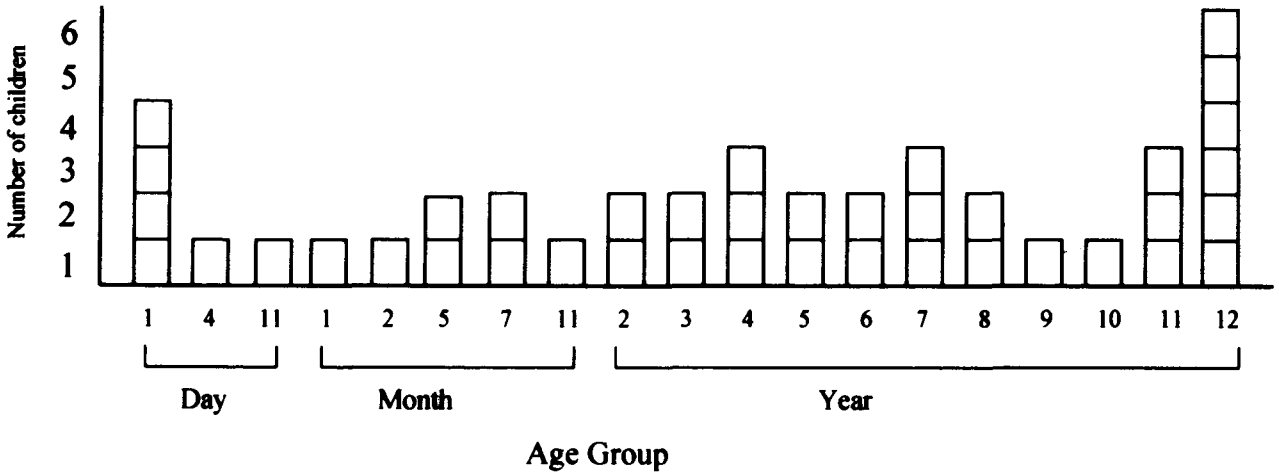

FIG. 1
A histogram of the age distribution of 40 patients at the time of tracheostomy.

performed, (iii) early post-operative complication was defined as that occurring within the first seven days after the operation, and (iv) that occurring after seven days was termed late post-operative complication.

Results

Children up to the age of 12 years were included in this study. During the same period a total of 200 tracheostomies in patients above the age of 12 years were managed. Hence the paediatric procedures constituted 20 per cent of the total tracheostomies in our setup. There were 21 (52.5 per cent) males and 19 (47.5 per cent) females in our series. The diagnosis of these patients are given in Table I where laryngotracheal pathology constituted the largest number of patients. The indications of tracheostomies were divided into three categories in these 40 children as, i) upper airway obstruction (32 patients or 80 per cent), ii) pulmonary toilet and assisted ventilation (five patients or 12.5 per cent), and iii) induction of general anaesthesia for other surgical procedure (three patients or 7.5 per cent). Thirty-two (80 per cent) children needed tracheostomies due to upper airways' obstruction. Six of these 40 children had had gestational prematurity. The diagnosis and gestational age of these six premature children are described in Table II. The age at tracheostomy of all children are represented in the form of a histogram in Figure 1. Six children at the age of 12 years constituted the largest numbers of any particular age.

Among these 40 cases nine (22.5 per cent) patients underwent the operation under local anaesthesia and 31 (77.5 per cent) of them under general anaesthesia. The diagnosis and age of nine children in whom tracheostomies were performed under local anaesthesia are mentioned in Table III. In this group of patients one each of nasopharyngeal angiofibroma, nasopharyngeal rhabdomyosarcoma and laryngeal papilloma were performed by general surgeons at the provincial hospitals. Eight (20 per cent) children were intubated pre-operatively in the general intensive care unit upon their admission to hospital and subsequently underwent tracheostomies. In 17 (42.5 per cent) children successful endotracheal intubations were possible before the onset of the operation in the operating room. In six children (15 per cent) there was extreme urgency due to severe breathing difficulties when 'crash' tracheostomies were performed following bronchoscopic intubation or cricothyrotomy followed by intubation. The diagnoses of these six children are given in Table IV.

Thirty-five (87.5 per cent) tracheostomies were performed by otolaryngologists (consultant/registrar) and five (12.5 per cent) patients came to us for further management after tracheostomies by general surgeons at the provincial hospitals.

TABLE III
DIAGNOSES AND AGE OF NINE TRACHEOSTOMIES UNDER LOCAL ANAESTHESIA

Diagnosis	Age of the patient (in years)
Nasopharyngeal rhabdomyosarcoma	9
Nasopharyngeal rhabdomyosarcoma	7
Nasopharyngeal osteogenic sarcoma	11
Epidermoid cyst of the vallecula	12
Oropharyngeal lymphoma	12
Juvenile nasopharyngeal angiofibroma	12
Juvenile laryngeal papilloma	9
Mandibular osteomyelitis with trismus	11
Infected mandibular dentigerous cyst with trismus	11

TABLE IV
PROCEDURES AND DIAGNOSES IN SIX CHILDREN WITH 'CRASH' TRACHEOSTOMY

procedure	Diagnosis	Number of patient
Cricothyrotomy followed by intubation	i) Bilateral congenital choanal atresia	1
	ii) Laryngeal papilloma in Down's syndrome	1
	iii) Ruptured epiglottic abscess	1
Bronchoscopic intubation	i) Bilateral congenital choanal atresia	1
	ii) Infected cystic hygroma	1
	iii) Tracheal foreign body	1

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TABLE V
DEFINITIVE OPERATIONS PERFORMED

Procedure	Number of patient
Laryngoscopy and bronchoscopy	29
Removal of laryngeal papilloma	6
Excision of the nasopharyngeal angiofibroma, osteogenic sarcoma and rhabdomyosarcoma	5
Cautery of the excessive peristomal granulation	5
Canalisation of choanal atresia	4
Excision of cystic hygroma	3
Microlaryngoscopic excision of the vallecular cyst	2
Surgery for mandibular pathology	2
Reconstruction of the subglottic stenosis with cartilage graft	2
Removal of tracheobronchial foreign body	2
Closure of tracheocutaneous fistula	2
Removal of the peristomal granulation and refashioning of the tracheostoma	1
Partial maxillectomy	1

Among these 40 patients 34 (85 per cent) underwent 'planned' tracheostomies and six (15 per cent) underwent 'crash' procedures. The different operations that were performed during, and following, the tracheostomies are mentioned in Table IV. Laryngoscopy and bronchoscopy was the commonest procedure performed on the largest number of patients. In one patient 26 laryngoscopies were performed for juvenile laryngeal papilloma. This patient followed up with us for five years and was ultimately decannulated. He, subsequently, had tracheomalacia but it did not require any further surgical intervention. The duration of tracheostomies in these 40 cases are described in the form of a histogram in the Figure 2. Six patients (three with juvenile laryngeal papillomas, one with subglottic stenosis, one with laryngomalacia and the post-operative Blalock-Taussig shunt in Fallot's tetralogy with left vocal fold paralysis) are awaiting decannulation and are in home care with their tracheostomies. They are being followed up at the clinic at regular intervals. The maximum duration of tracheostomies was in between one week to a month and one month to three months, each containing 11 (27.5 per cent) patients.

The post-operative complications are mentioned in Table VI. There were no intra-operative complications in our series. The most common early and late complications were tube obstruction and stomal granulation respectively. All the early complications took place in the hospital. One case of accidental decannulation and tube obstruction in the late post-operative complication group took place at home. Among these 40 children with tracheostomies 11 (27.5 per cent) died (Table VII). Of these 11 deaths, one (2.5 per cent) was due to the tracheostomy itself and the rest 10 (25 per cent) were due to the primary disease process. The intra-operative death was caused by an irregular metallic tracheal foreign body tearing the tracheal mucosa during the process of removal through the tracheostoma. Tracheostomy was necessary due to the urgency of the situation and

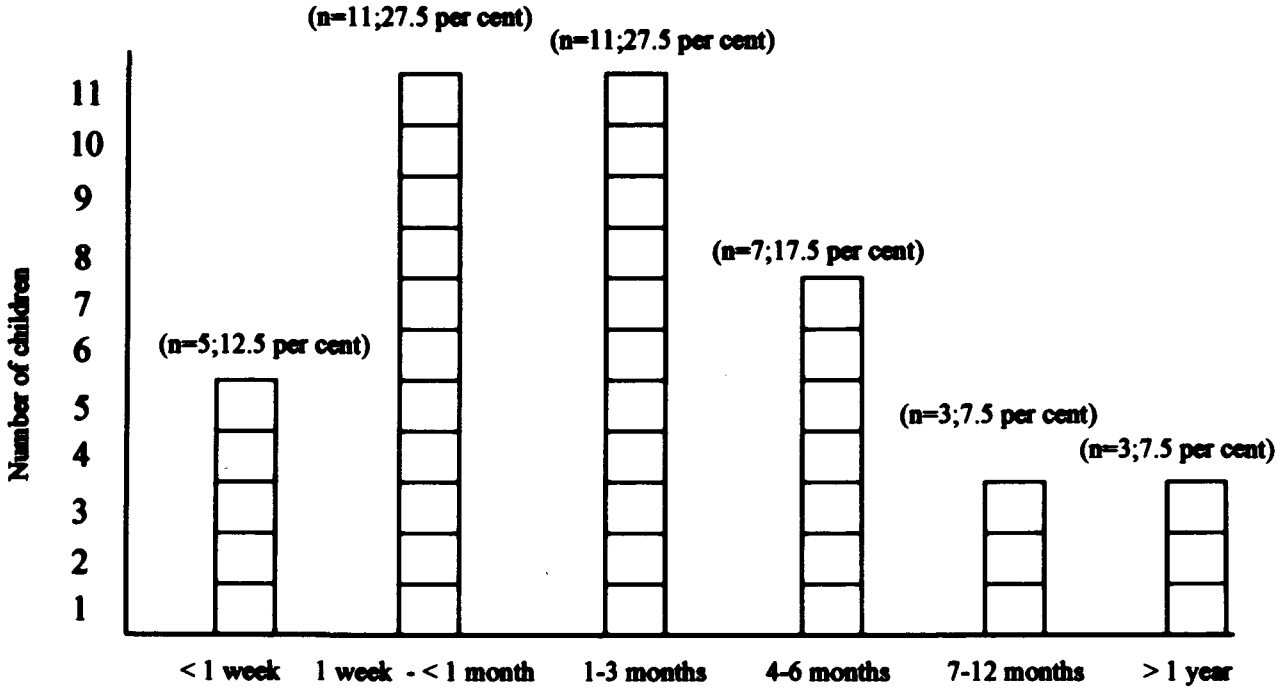

FIG. 2
A histogram of the duration of tracheostomies in 40 children

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TABLE VI
POST-OPERATIVE COMPLICATIONS

Diagnosis		Number of patient
I.	Early post-operative (n = 9, 22.5 per cent)	
	Tube obstruction	4
	Accidental decannulation	2
	Pulmonary oedema	1
	Pneumomediastinum	1
	Death	1
II.	Late post-operative (n = 14, 35 per cent)	
	A. Major	
	Tracheocutaneous fistula	2
	Accidental decannulation	2
	Tube obstruction	1
	Tracheal granuloma	1
	B. Minor	
	Excessive stomal granulation	6
	Stomal infection	1
	Tracheomalacia	1

to save the vocal folds from trauma by the foreign body during peroral endoscopic removal. One patient with laryngomalacia with dextrocardia with situs solitus died in the immediate post-operative period (within five hours of operation) due to pneumomediastinum with heart failure. Parents of this patient refused autopsy. Hence, we were not able to detect the existence of any additional cardiac abnormality. One patient with oropharyngeal lymphoma was lost to the follow-up following his treatment. No complication was noted in three patients in whom tracheostomies were performed for induction of general anaesthesia for other surgical procedures. No airway narrowing was noticed in the follow-up of three children who underwent cricothyrotomy-intubation before their tracheostomies.

Discussion

There are several series of the results of paediatric tracheostomy in the literature. Kenna *et al.* (1987) analysed their experience of tracheostomy in preterm infants. Gianoli *et al.* (1990) reviewed their results of this procedure in the first year of life. Line *et al.* (1986) analysed their 15 years' experience of paediatric tracheostomy in the age group up to three years. Other studies described the experiences in a broader age group of paediatric patients (Wetmore *et al.*, 1982; Carter and Benjamin, 1983; Gilmore and Mickelson, 1986; Crysdale *et al.*, 1988). Each of these investigators noted that tracheostomy in children is a more hazardous procedure with difficult post-operative management and was more likely to have post-operative complications and deaths than in adult patients. Kenna *et al.* (1987) found higher complication rates in pre-term infants with tracheostomy which is attributed more due to gestational age, low birth weight and medical condition than the surgical technique itself.

In our series, the age of these 40 children are divided into four groups, namely, within one year, one to four years, five to eight years and nine to 12 years with 13 (32.5 per cent), seven (17.5 per cent), nine (22.5 per cent) and 11 (27.5 per cent) patients respectively. Other series also described the largest number of patients under the age of one year (Line *et al.*, 1986; Gilmore and Mickelson, 1986). In accordance with other series there is higher inci-

TABLE VII
CAUSES OF DEATH IN 11 CHILDREN

Diagnosis	Interval between tracheostomy and death	Cause of death	Decannulation Yes/No	Number of patient
Infected cystic hygroma	3 weeks	blood transfusion reaction in post-operative period	no	1
Laryngomalacia (with dextrocardia with situs solitus)	5 hours	pneumomediastinum with heart failure	no	1
Snake bite	2 days	intracranial haemorrhage	no	1
Severe burn	1 day	acute renal failure	no	1
Bilateral congenital choanal atresia	3 months	pneumonia	yes	1
Nasopharyngeal rhabdomyosarcoma	within 4 months	systemic metastasis	yes	1
Nasopharyngeal rhabdomyosarcoma	within 6 months	systemic metastasis	yes	1
Nasopharyngeal osteogenic sarcoma	2 months 1 week	intracranial extension	yes	1
Kaposi's sarcoma	3 weeks	systemic dissemination	no	1
Tracheobronchial foreign body	intra-operative	pneumothorax with pneumomediastinum	no	1
Laryngeal papilloma (with Down's syndrome)	6 months	pneumonia	yes	1

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dence of tracheostomy in male patients in our series; and it probably represents an increased male susceptibility to congenital and acquired disorders (Wetmore *et al.*, 1982; Gilmore and Mickelson, 1986; Line *et al.*, 1986; Crysdale *et al.*, 1988; Gianoli *et al.*, 1990; Dutton *et al.*, 1995).

The indications of tracheostomy in children are diverse and extensive (Swift and Rogers, 1987). Due to improvement of neonatal medicine, some of the infective airway conditions, such as laryngotracheobronchitis, acute epiglottis, are nowadays better managed by intubation and conservative treatment in preference to tracheostomy (Carter and Benjamin, 1983; Swift and Rogers, 1987). Despite this shift towards conservative management for infective airway diseases, upper airway obstruction is still the most common indication for tracheostomy in children in most of the reported series (Gilmore and Mickelson, 1986; Line *et al.*, 1986; Swift and Rogers, 1987; Crysdale *et al.*, 1988). In our series the upper airway obstruction constituted the commonest (80 per cent) indication for tracheostomy. In our setup the juvenile laryngeal papillomas required tracheostomies as i) they presented with advanced disease with marked stridor, and ii) there was no CO_2 laser in our set-up. Conditions such as laryngotracheal foreign body, juvenile laryngeal papilloma, constituted some of the indications for tracheostomy in contrast to the series reported from the developed countries. Our experiences in these diseases are similar to those that had been noted by authors from other developing countries (Okafor, 1983; Soni *et al.*, 1984).

In nine children we performed tracheostomies under local anaesthesia. These children belonged to an older age group and were more cooperative. There is no paediatric intensive therapy unit (ITU) in our hospital. Hence, we felt that it was a safer option in our setup to perform tracheostomy instead of long-term intubation for induction of general anaesthesia in other surgical procedures in three patients. Where facilities of such paediatric intensive therapy unit are available long-term intubation in such situations would be a better option. In our series there were six (15 per cent) pre-term children who were less than 37 weeks of gestational ages. Among these six pre-term children one died due to a tracheostomy-related complication and another death was not related to tracheostomy. These findings corroborates with Kenna *et al.* (1987) who found that there were higher complication rates among the pre-term patients than among the full-term ones.

In our series, nine (22.5 per cent) had early post-operative and 14 (35 per cent) had late post-operative complications. Tracheostomy tube obstruction and stomal granulation constituted the largest number in the early and late post-operative complication groups respectively. Depending upon the importance and the severity we have divided the late post-operative complications into major and minor categories. Line *et al.* (1986) reported the incidence of early and late complications of 12 per cent and 26 per cent respectively. Carter and Benjamin (1983) concluded that stomal granulations occur so commonly that they should not be listed as complications unless they create significant obstruction to the airway. All six patients with excessive stomal granulation in our series had their tracheostomy tubes in situ for more than three months. In our series the incidence of tracheocutaneous fistula was very low (two patients, or five per cent). This was due to the short-term nature of duration (up to three months) of tracheostomies in over half of the children (27 patients, or 67.5 per cent), and only three children had tracheostomies more than one year. In various series the reported mortality rates for children with tracheostomy varies from 11 per cent to 40 per cent; however the death specifically attributed to tracheostomy in children is only 0 per cent to 3.4 per cent (Wetmore *et al.*, 1982; Line *et al.*, 1986; Crysdale *et al.*, 1988; Gianoli *et al.*, 1990; Dutton *et al.*, 1995). The mortality rate in our series corroborates those mentioned earlier. Ten patients (25 per cent) in our series died due to their primary disease process. In this group one patient died due to a second primary malignancy (Dubey *et al.*, 1996). There was no tracheostomy-related death in the Carter and Benjamin (1983) series of 164 children under the age of 13 years.

Conclusion

The changes in the disease patterns and their management have altered the diverse indications for paediatric tracheostomy over the years. Short-term endotracheal intubation in airway obstruction for acute infections and long-term intubation for patients on ventilators have replaced early tracheostomy in these conditions. In contrast, conditions such as airway infection, juvenile multiple laryngeal papilloma, laryngotracheal foreign body and airway access for induction of general anaesthesia, still constitute the indications of tracheostomies in children where the patient usually presents at a late stage of the disease, and where the advanced patient care facilities such as a paediatric intensive therapy unit and CO_2 laser are not available.

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