Burden of Bronchiectasis in Indigenous Peoples - How Can it be Improved?

Karen Munro[1], Rosalyn J. Singleton[2], Elizabeth A. Edwards[1], Gregory J. Redding[3], Anne B. Chang[4] and Catherine A. Byrnes[*,1,5]

[1]*Starship Children's Health, Auckland District Health Board, Auckland, New Zealand*

[2]*Alaska Native Tribal Health Consortium, Anchorage, Alaska, USA*

[3]*University of Washington School of Medicine, Paediatric Pulmonary Division, Children's Hospital and Regional Medical Centre, Seattle, Washington, USA*

[4]*Child Health Division, Menzies School of Health Research, Charles Darwin University, Darwin, and Queensland Respiratory Centre, Royal Children's Hospital, Brisbane, Australia*

[5]*Faculty of Medical and Health Sciences, University of Auckland, Auckland, New Zealand*

Abstract: Bronchiectasis remains common in indigenous populations as reported from Alaska, Australia and New Zealand. Each of these countries has published incidence and prevalence estimates, suggested aetiologies, clinical course and associated factors which may contribute to the burden of disease. The purpose of this collaborative review is to summarise literature on bronchiectasis in indigenous peoples, discuss similarities and differences between these groups and countries, and compare these findings to recent reports on non-indigenous populations. Difficulties in applying best management practice are highlighted, including the difficult and confusing terminology, and suggestions made to address the unmet healthcare needs in order to reduce future respiratory morbidity and mortality in these populations.

Keywords: Indigenous, bronchiectasis, chronic cough, pneumonia, poverty, children, chronic respiratory disease.

BACKGROUND

Bronchiectasis is characterised by irreversible dilatation of the airways associated with frequent bacterial infections and inflammatory destruction of bronchial and peribronchial tissue. Clinically it presents with frequent acute respiratory exacerbations on a background of chronic lower respiratory tract infection resulting in significant respiratory morbidity and early mortality [1, 2]. With the advent of high resolution computed tomography (HRCT) as a diagnostic tool, reports over the last decade suggest that bronchiectasis is more common than previously suspected [3-6]. The prevalence and health impact of bronchiectasis remain particularly high among indigenous peoples, including Alaska Native, Australian Aborigine, New Zealand Māori and Pacific populations. As many cases may be preventable, bronchiectasis is an important public health issue for these communities.

For this review, we define indigenous peoples as inheritors and practitioners of unique cultures who have retained distinct social, cultural, economic and political characteristics [7]. Despite cultural differences, groups of indigenous peoples share common problems related to the protection of their rights as distinct peoples. Definitions used for the ethnicity of the indigenous peoples have varied over time and between publications. This has important implications when interpreting rates of disease within indigenous populations over time and between different populations [7]. The purpose of this review is to summarize the literature on bronchiectasis in indigenous children from Alaska, Australia and New Zealand (NZ) to determine similarities and differences within these populations. This will then be compared to reports on non-CF bronchiectasis in non-indigenous populations.

*Address correspondence to this author at the Paediatric Department, Faculty of Health and Medical Sciences, University of Auckland, Private Bag 92019, Auckland, New Zealand; Tel: +64 9 373 7599 (Ext) 89770; Fax: +64 9 373 7486; E-mail: c.byrnes@auckland.ac.nz

REVIEW OF PAEDIATRIC BRONCHIECTASIS IN INDIGENOUS PEOPLES

Alaska Native Peoples

Alaska Native (AN) children have been recognized to experience high rates of non-CF bronchiectasis since the 1950s. In 1968 Fleshman *et al.* estimated that the average annual incidence among Alaska Native children less than 10 years of age was 3.89 per 10,000 [8]. The Yukon-Kuskokwim (YK) Delta region is in the southwest Alaska. Although 20% of the Alaska Native population resided in this region, 45% of bronchiectasis cases resided here [8]. This remote region of 52 villages is comprised of mostly Yup'ik people with a subsistence lifestyle, in villages accessible by small aircraft, snowmobile or boat. Houses are often small and approximately 40% lack running water. Improvements in housing, public health, nutrition and water supply have resulted in dramatic decreases bronchiectasis in Alaska as well as in the United States of America generally [9]. However, the prevalence of bronchiectasis in the YK Delta remains high - estimated at 12-20/1,000 births. Since the 1970s, more than 80% of AN persons with bronchiectasis

1573-3963/09 $55.00+.00

reside in YK Delta which is home to only 20% of AN people [6].

In 1968 Fleshman *et al*. described the epidemiology of bronchiectasis, then diagnosed by bronchography, in 100 AN children [8]. Aetiology was difficult to determine because childhood illnesses were frequently not documented and tuberculosis (TB) was endemic. Of the 100 cases, 38 were associated with a preceding pneumonia (3 from measles) and 18 were related to pulmonary TB. The mean age of diagnosis was 4 years for non-TB and 8 years for TB-related disease. Cough, haemoptysis, sputum production and recurrent pneumonia were the most common symptoms. Sixty percent of the children had chronic otitis media. Bronchiectasis was bilateral in 38 patients and localized to one lobe in only 46 patients. Fifty-three patients underwent surgical lobectomy.

In 2000 Singleton *et al.* described the causes and clinical courses of 46 children with bronchiectasis from the YK Delta [6]. In over 90% there was a history of recurrent pneumonia in early childhood with 24 (52%) hospitalized in the first year of life for lower respiratory tract infection (LRTI). The median age of first LRTI was 4.8 months while the median age of bronchiectasis diagnosis was 4.8 years. There was a median of 7 (range 1-33) visits for LRTI before the diagnosis of bronchiectasis was made. The causative agent was unknown in most cases. Bilateral disease occurred in 17/28 (61%) of definite cases confirmed by bronchogram or CT, and in 9/18 (50%) of probable patients determined by chest radiography [6]. Bronchiectasis was limited to one lobe in only 10 (22%) patients. The lobes involved with bronchiectasis were those most severely affected before diagnosis. Co-morbid conditions included asthma in 34 (74%). Thirty-eight (83%) patients were managed medically with antibiotics, bronchodilators and/or postural drainage. Eight patients (17%) underwent lobectomy.

In 2004 Redding and Singleton reported a 5 year follow-up evaluation of 95 patients hospitalized with respiratory syncytial virus (RSV) infection and 113 village-matched control subjects from a 1993-1996 case-control study [10]. Review of historical chest X-Rays from birth to the follow-up visit showed evidence of bronchiectasis in 10 (11%) RSV cases and 10 (9%) controls by $\geq$2 years of age. Presence and persistence of parenchymal densities (infiltrates) in both groups at < 2 years of age were most closely associated with later development of bronchiectasis (RR = 3.92, p = 0.013). Although clinic visits for respiratory infections were similar in the first year of life, children with $\geq$5 clinic visits for respiratory infections in the second year of life were more likely to develop bronchiectasis.

Aboriginal and Torres Straits Island Peoples (Australia)

The burden of respiratory disease affecting Aboriginal Peoples and Torres Strait Islander Peoples (hereafter referred to as Indigenous Australians) remains high [11, 12]. Death rates from respiratory diseases in Indigenous Australian adults (excluding lung cancer) are 5-6 times higher than non-Indigenous Australian adults [13]. Australia-wide, respiratory disease affecting the Indigenous Australian population is the most common cause of hospital admissions in females (excluding child-birth) and the second most common cause of admissions in males (after injury) [14]. In the most recent national health survey, 31% of Indigenous Australians self-reported 'diseases of the respiratory system' as a long-term medical problem [15]. It is unknown what proportion of this morbidity is associated with symptoms from bronchiectasis and chronic suppurative lung disease (CSLD, see definition under 'Case Definition' below). Cough is commonly under-reported by Indigenous Australians and additional medical information from the local community (clinic staff, notes, carers, health workers) about the nature and duration of cough is often helpful.

The true prevalence of CSLD and bronchiectasis are unknown but there is little doubt that the burden of both conditions is disproportionately high in rural indigenous communities. In Central Australia the prevalence of bronchiectasis in children (<15 years) is 147/10,000 Aboriginal children [16]. This far exceeds the prevalence of children with cystic fibrosis (CF) in non-Indigenous Australian children (3.5/10,000), yet there remains no concerted program or resources to manage these children and adults. A retrospective Central Australian study described that adults hospitalised with bronchiectasis had a mean FEV_1 in those tested of only 36% predicted, despite being a relatively young cohort (23% aged < 30 years) [17].

In the Alice Springs series of childhood bronchiectasis, 12.2% of children had a major contributing factor such as IgG subclass deficiency, congenital/airway lung lesions, severe aspiration or TB [16]. There are no published Australian studies on the underlying aetiology of CSLD in Indigenous Australian adults but it is widely assumed that the majority of adulthood CSLD has its origins in childhood.

The most significant medical risk factor identified in a case control study was recurrent pneumonia, often severe requiring oxygen and prolonged hospitalization [18]. Other risk factors were birth before 31 weeks gestational age and atelectasis on a preceding chest radiograph. The only protective factor was breast feeding [18]. In a 12-month follow-up study in Central Australia, 19.7% of those evaluated following lobar pneumonia had a subsequent new diagnosis of CSLD.

NZ Māori and Pacific People

Reports of bronchiectasis in NZ adults appeared in the 1950s [19] and again in the early 1990s [1] giving rates of 50/100,000 deaths in Māori and Pacific peoples. Bronchiectasis remains the 7th leading cause of death in Pacific women [2]. More recent reports have documented a high incidence [5] and prevalence [4] in NZ Māori and Pacific children.

In 2000 a retrospective review of children attending a bronchiectasis clinic found a crude prevalence rate of 1/6000 in the Auckland paediatric population [4]. A prospective, national study reporting all new cases diagnosed 2001-2003 using the NZ Paediatric Surveillance Unit gave an incidence of 3.7/100,000 children per year [5]. This is seven times more frequent than the only other comparable national study from Finland [20]. Eighty percent of the children were Māori or Pacific peoples [4] indicating a disproportionate prevalence of bronchiectasis at 1/625 for Pacific peoples, 1/1700 for Māori and 1/3000 overall. Bronchiectasis is four times as common in Pacific peoples as CF is in the general population.

Both studies used HRCT diagnosis and history of chronic cough, with haemoptysis rarely reported. The median age at diagnosis declined from 8 years in the first to 5.2 years in the second study, with age of onset of respiratory symptoms and an age of first hospitalization for respiratory disease both at a median of 1 year [4, 5]. This suggests most cases developed in early childhood but diagnosis was significantly delayed. Bronchiectasis was bilateral in 87% and 83% of children, in more than 3 lobes in 82% and 61% and involving all lobes in 20% (both studies) in the regional [21] and national [5] studies respectively. The majority had digital clubbing (52%) and chest deformity (60%) [21].

Despite extensive investigation, the aetiology of bronchiectasis was unknown in half of both series. Of those with identified aetiologies, 22-25% followed a significant pneumonia (adenovirus, pertussis, TB, *Staphyococcal aureus*, *Streptococcal pneumoniae*, mycoplasma, aspergillus), 6-12% were due to primary immunodeficiency, 7-11% occurred after oncological treatment and 6-10% were due to aspiration. In the 1970s Becroft [22-24] described the development of bronchiectasis in 60% of 43 paediatric patients 13 years after hospitalization with adenovirus 21 bronchiolitis. Almost 10% of cases were deemed secondary to adenoviral infections in the recent series.

There had been historical concerns regarding Primary Ciliary Dyskinesia (PCD) in Māori and Pacific populations [25-28]. Investigations of this are under-resourced in NZ but in the retrospective study, none of those with an unknown cause for their bronchiectasis were ultimately diagnosed with PCD [21]. In contrast, secondary ciliary defects were common – three times higher than reported in controls from the literature. There was no difference between ethnic groups, and while the percentage of ciliary structural defects was higher in the children with bronchiectasis than in control children, the difference was not statistically significant [29].

Haemophilus influenzae (HI) was the most commonly isolated organism in 83% of those who were able to provide sputum specimens. Comorbid asthma was present in 37% [4]. The mean FEV_1 was 69% and 77% for the regional and national cohorts [4, 5]. Those with post-infectious bronchiec-

Table 1. Comparison of the Features of Bronchiectasis in these Three Indigenous Populations

Parameters	Alaska Native Peoples	Aboriginal & Torres Straits Island Peoples	NZ Māori & Pacific People
Case Definition	Bronchiectasis on bronchography in earlier studies [8], chest X-Ray (probable) or HRCT scan (definite) in later studies [6, 10]	CSLD – clinical symptoms without radiological confirmation, Bronchiectasis on chest X-Ray and/or HRCT scan [16-18]	Bronchiectasis on HRCT scan [4, 5]
Incidence	3.89/10,000 [8]	-	0.37 / 10,000 (0.5 Māori, 1.8 PI)
Prevalence	110-205/10,000 [6]	147/10,000 [31] 49/10,000 [3]	3.3/10,000 (5.5 Māori, 16 PI) [5]
Age of Diagnosis	4 yrs non TB, 8 yrs TB [8] 4.8 years [6]	5.3 yrs [18] 4.8 yrs [3]	8 yrs [4] 5.2 yrs [5]
Delay in Diagnosis	Approx 4 yrs after first hospitalisation [6]	2-8 months post pneumonia [18] Not identified in most of the studies	2 yrs chronic cough 4 yrs from first hospitalisation [4, 5]
Disease Severity	38% bilateral 46% unilobar [8] 57% bilateral 10% unilobar [6]	15.3% > 2 lobes 32.2% 2 lobes 52.5% unilobar [3] 50% bilateral 42% unilobar [16]	83% bilateral 64% > 3 or more lobes 16% unilobar [5] 87% bilateral 82% > 3 or more lobes 62% > 4 or more lobes 9% unilobar [4]
Aetiology	56% post infectious / TB [8] 93% LRI by 2 yrs age 52% LRI requiring hospitalisation [6]	95% post pneumonia especially repeated (> 2-3) or prolonged hospitalisation (5 weeks) [18] 39.7% abnormal airway 12.2% immunodeficiency [16]	75% and 76% unknown or post infectious [4, 5] 10% & 6% aspiration 12% & 6% immunodeficiency
Nutrition	Malnutrition not identified as a factor	84.2% malnutrition [18] 17% > 2 standard deviation below for weight [3]	Malnutrition not identified as a factor Micronutrient deficiency with pneumonia documented [32]
Immunisation Coverage	> 90% routine vaccination [33]	84.2% routine vaccination 100% measles/pertussis [18]	< 70% routine vaccination [4]
Association with Asthma	74% [6]	21% [3]	37% [4]
Association with Otitis Media	60% [8]	59% [18]	18% [4]
Socioeconomic Status	Lack of running water [34]	Geographical isolation 66% > 180km from Alice Springs Poor living conditions High use of biomass combustion [18]	59% & 67% living in the 30% most deprived regions of New Zealand [4, 5]

tasis and chronic HI infection were found to have more severe airway obstruction and those diagnosed following oncology treatment had less severe disease. Over time, lung function deteriorated at about 2% per annum, with no change in the rate of decline according to aetiology [5, 30].

SIMILARITIES SEEN IN INDIGENOUS AND NON-INDIGENOUS POPULATIONS WITH BRONCHIECTASIS (TABLE)

Table **1** summarises the similarities and differences between these three indigenous groups.

- Age of and delay in diagnosis

  The median ages of diagnosis of bronchiectasis have most recently been reported from 4.8 to 5.2 years [4-6, 18]. However, prior to diagnosis all have reported symptoms of chronic wet or productive cough for prolonged periods with median age of onset of symptoms as young as 4.8 months [6] and average time from symptoms to diagnosis from 3.6 to 4.9 years.

- Lobar distribution of disease

  The extent of lobar distribution of bronchiectasis seems greater in recent paediatric reports compared to early bronchiectasis literature in which many more than half of the bronchiectasis patients appeared to have single lobe disease amenable to surgery. With one exception, most recent reports describe single lobar disease in 9-29% of different indigenous groups [3, 5, 6, 21]. The most extensive disease has been reported in NZ children [4, 5] and by age 10 they were shown to have more severe obstructive lung disease than children with CF [30] managed by the same medical team.

- Recurrent respiratory disease

  Across all three countries, children develop bronchiectasis in the setting of extremely high rates of childhood pneumonia [10, 12, 35]. Correspondingly, previous severe pneumonia is a presumed aetiology in significant percentages for those with already established bronchiectasis [3-6, 10, 18]. The Alaskan and Australian studies have shown a strong association between hospitalized pneumonia and later bronchiectasis [6, 10, 18]. Children who continue to have frequent LRTI in the second year of life may also be at greater risk [6]. Parenchymal infiltrates on chest X-Ray were more likely to lead to bronchiectasis, with the areas of later scarring relating to the areas with most changes seen earlier [3, 6].

- Socioeconomic considerations

  These high rates of respiratory disease occur in settings of poverty, extreme household overcrowding, and low parental education level and in some cases lack of access to running water for hand hygiene [3, 5, 6, 18, 36]. In Alaska, lack of in-house running water was associated with higher risk of LRTI and pneumonia hospitalizations [34]. In NZ, 67% of those with bronchiectasis lived in the 30% most deprived regions of NZ [4]. In addition, low immunisation rates (complete in < 70%) were documented [4]. Language difficulties, with 27% of families attending clinic requiring interpreters, will also affect access to health care services [4].

- Association with asthma

  Allowing for differences in diagnostic criteria, asthma has been associated with bronchiectasis since early work in the middle of last century [37, 38] and in studies in adult bronchiectasis or asthmatic populations [39-42]. In Alaska over 90% of children in YK Delta experience wheezing during the first year of life [43]. This incidence of wheezing decreases during the first 5 years of life among YK children, but two thirds of those with bronchiectasis have co-morbid asthma [6, 10]. Asthma co-morbidity is much lower among Australian Aboriginal children at 21% [3] and Māori and Pacific children at 37% [4]. Interestingly, it has been associated with a slower decline of lung function in one longitudinal study (median 5.7 years duration) from NZ [30]. While some authors have suggested asthma as a 'cause' of bronchiectasis [44, 45], it is unclear whether it is a characteristic of those who develop bronchiectasis or simply one background paediatric condition upon which bronchiectasis develops [45, 46].

- Association with otitis media

  A significant association with otitis media has been reported in the Alaskan and Australian cohorts. Its presence raises questions about the impact of nasopharyngeal carriage of bacterial pathogens and continued seeding of the lower airways among children predisposed to bronchiectasis [47, 48].

- Chronic infection with non-typeable *Haemophilus influenzae*

  High rates of HI infection are found in all these communities. In contrast, the Staphylococcal and Pseudomonal infections associated with CF have been rarely documented. The presence of these organisms should prompt investigations for underlying aetiologies - especially CF, PCD and primary immune deficiency [4, 6].

- High morbidity & mortality rates in early adulthood

  High adult mortality from bronchiectasis has been documented in these communities [1, 2, 17]. Mortality rates are likely to be underestimated due to different definitions of ethnicity and difficulties in diagnostic coding. In the adult population there is significant overlap between bronchiectasis, chronic obstructive pulmonary disease (COPD) and emphysema [49, 50]. In addition, hospitalisation rates for bronchiectasis have been increasing significantly in NZ since the late 1990s (Fig. **1**). Many of these cases had symptoms preceding the diagnosis that began in childhood.

DIFFERENCES REPORTED BETWEEN INDIGENOUS GROUPS AND WITH NON-INDIGENOUS POPULATIONS

- Case definition of bronchiectasis

  The case definition of bronchiectasis has differed among reports on indigenous and non-indigenous children, using combinations of HRCT, chest radiography, bronchography and/or clinical symptoms as diagnostic cri-

teria. Some of this is explained by the increased use and access to HRCT scans in the last decades. Although HRCT criteria have become the gold standard for the diagnosis of bronchiectasis, access to these scans remains difficult in communities with less resources and/or geographical isolation. Chronic suppurative lung disease (CSLD) is a term developed to describe respiratory symptoms and signs consistent with bronchiectasis in children who do not have the radiographic features. Common symptoms include prolonged wet cough, exertional dyspnoea, asthma-like symptoms and recurrent chest infections. Clinical signs include growth failure, clubbing, chest wall deformity, hyperinflation and adventitial sounds on chest auscultation. In advanced disease chronic hypoxaemia and signs of pulmonary hypertension may be present. In children triggers for referral to a specialist include: > 2 episodes of chronic (> 4 weeks) wet cough per year responding to antibiotics, and persistent chest radiographic abnormality.

- Poor nutrition/growth

  In Central Australia, children with bronchiectasis were three times more likely to have had malnutrition in early childhood prior to the diagnosis of bronchiectasis [18]. Seventeen percent of children had weight Z scores below the 2 standard deviations of WHO-determined criteria [3]. In contrast, malnutrition was uncommon in Alaskan [6], Māori and Pacific children [4, 5] and was not reported in studies from Turkey [44, 45] and the United Kingdom (UK) [51]. Micronutrient deficiencies, however have been reported in NZ children with recurrent respiratory disease [32].

- Underlying aetiology

  A specific underlying aetiology was rarely identified in studies involving indigenous children with either 'unknown cause' or 'previous pneumonia' most commonly reported. There were only small numbers of children with immunodeficiency and HIV was rare. While studies in non-indigenous children from North England [51] and Turkey [44, 45] still described post-infectious causes in 30% and in the majority of cases from Taiwan [52, 53], they were also more likely to have identified predisposing disorders. For example, in the North England study there were only 18% with cause unknown following investigations [51]. Rates of PCD found in the studies from Turkey were high at 6-13% [44, 45]. One study from two paediatric specialist hospitals in England established aetiology in 101 of 136 referred patients with immunodeficiency (34%), aspiration (18%) and PCD (15%) being common causes, childhood respiratory infection accounting for only 4% of cases, and no cause found in 26% [54].

- Parental consanguinity

  This was high in the Turkish population but has not been described as a feature in the other populations presented here. This would increase the likelihood of autosomal recessive disorders (Primary Immune Deficiency, PCD and CF) which need careful exclusion.

- Rates of chronic Pseudomonas infection

  Chronic Pseudomonas infection is rare in indigenous children from Australia, Alaska and NZ compared with reports in other populations such as Turkey and the UK (where it is said to occur in 7.5 to 29%) [45, 46, 51, 54]. This also may relate to age of acquisition in young adulthood rather than childhood among those with non-CF bronchiectasis.

- Disease severity and progression

  The studies from the Turkish cohorts had 43.3% and 46% with unilobar disease and they found that lung function improved over time [44, 45]. Eastham also reported resolution in some children [51]. This contrasts with the severity reported in the Alaskan [6] and NZ [4, 5] populations and with the deterioration reported over time [6, 30]. Reversible bronchiectasis has been reported [55], with removal of foreign body [56] and in those developing bronchiectasis during immunosuppressive treatment for oncological disease (personal communication) or treatment of TB.

ISSUES IN APPLYING BEST PRACTICE MANAGEMENT

In households of children with bronchiectasis, there are often other family members with similar symptoms or who have a bronchiectasis diagnosis or some may have seen close family members die from bronchiectasis. This, added to lack of knowledge about the disease, perpetuates the barriers generated through language difficulties and lack of culturally appropriate information. Even the word bronchiectasis is difficult to say and spell and is often incorrectly recognised and assumed to be 'bronchitis' or 'bronchiolitis' underestimating the major issues and outcomes in terms of morbidity and mortality. In NZ, the term 'BX' is used in order to simplify the terminology and avoid confusion with other respiratory illnesses such as bronchiolitis, bronchitis and TB. Ideally, international adoption of a term such as 'BX' would raise awareness, as has happened with other acronyms, for example the use of 'CF' and 'PCD'.

- Lack of evidence based medicine to guide management

  While there are best practice guidelines published for the care of adults [57] and children with bronchiectasis [58, 59], there is a lack of evidence to substantiate current therapies. There is also a dearth of long term prospective outcome data which could highlight factors associated with early mortality or the development of severe disease.

- Geographic barriers to healthcare

  Most children with bronchiectasis in Alaska and Australia live in remote indigenous villages with limited access to specialist physician health care. For example, children diagnosed with bronchiectasis were 3 times more likely to reside outside Alice Springs and its surrounding communities [18]. In Alaska 80% of those with bronchiectasis came from the 20% of the general population in the more isolated region of the YK delta [6]. A transient lifestyle has also been documented with 15% of NZ children moving out of region over a 5 year period (unpublished).

- Limited resources

  Bronchiectasis is the poor cousin of CF or PCD, which has well established standards of care, an expected network of health care workers with strong charitable support and collective family drive to insist on improved care [60, 61]. In comparison, the limited research base in bronchiectasis makes it more difficult to argue for access to healthcare and medications. The populations most affected with bronchiectasis have fewer resources, and are also less able to effectively access care.

- Pockets of low immunization coverage

  High rates of immunization coverage for measles, pertussis, influenza, Haemophilus influenzae type b, and Streptococcus pneumoniae-containing vaccines are critical to the control of respiratory infections. Immunization rates for childhood vaccines are described as less than 70% in the studies of NZ children with bronchiectasis [4, 5] and up to 84.2% in cases and 80.6% in controls in Australian studies [18] with 100% coverage for measles and pertussis [59]. Alaska Native children have high immunization coverage rates (> 90%) for each routine childhood vaccine [33]. A policy of ensuring full immunization as per individual country's protocols as well as pneumococcal and influenza vaccination is recommended. National immunization registers are now available in Australia and NZ and a state registry is being implemented in Alaska.

- Thresholds for recognition and investigation of chronic wet cough

  The delay in recognition and investigation of chronic wet cough or prolonged and recurrent lower respiratory tract infections was universally found in all the studies across all populations. A recent Thoracic Society of Australia and New Zealand position statement [62] defines chronic cough as persisting for longer than 4 weeks, a relatively short period of time considering the longevity of cough in the children subsequently diagnosed with bronchiectasis [5]. A NZ masters thesis [63] undertaking interviews with NZ clinicians indicated a low index of suspicion for bronchiectasis amongst primary and secondary care. Education should be directed at hospital, primary care and community levels to improve the recognition of what is abnormal and what indicates the likelihood of CSLD and bronchiectasis.

- Non-indigenous health care delivery to indigenous peoples

  Health care delivery tends to apply a western paradigm to address the health needs of indigenous groups which is likely to be inappropriate – suiting the provider but not the community. The poor engagement between these at risk populations and providers include different cultural beliefs, inadequate communication and language barriers, all of which are compounded by the lack of culturally knowledgeable health workers. In NZ it was found that 27% of the children/families attending the bronchiectasis clinic did not speak English as their first language and required an interpreter for consultations [4].

COMMON STRATEGIES AND RECOMMENDATIONS

The potential for prevention of bronchiectasis and improved services for children with bronchiectasis requires political, professional and community focus and resources. However, a major step forward would be adoption of the terms CSLD and BX internationally.

A. Generic Recommendations

1. Promotion and prioritisation of health services that are culturally-appropriate can lead to a significant improvement in access to health services for indigenous people leading to earlier intervention, improved adherence and a greater sense of community participation and ownership [64]. In asthma, for example, culture-specific programs and involvement of indigenous health care workers have been demonstrated to provide superior care to generic programs [65, 66].

2. Use of appropriate cultural support workers when there are no indigenous peoples on the health care team to aid acceptance, communication and education.

3. Encourage and promote local health care initiatives for indigenous peoples. Individual initiatives across different countries and communities would take advantage of local strengths and resources. In New Zealand, "Healthy Village Action Zones" are targeting the large numbers of Pacific peoples who attend Christian churches to provide health promotion, healthy meals and exercise classes. Churches have combined to employ a nurse and indigenous Primary Healthcare Organisations have invited paediatricians to hold clinics within their sites to improve access to care. In Alaska indigenous health initiatives include smoking cessation initiatives, promotion of breastfeeding, and promotion of hand-washing, promotion of cultural foods and subsistence activities, and a campaign to prevent dental caries. Certified community health aides are available in each village (Alaska Native Tribal Health Consortium, Annual Report).

4. Advocate for increased government targeting of the determinants of health such as in-home plumbing, adequate housing and education.

5. Support National and State immunisation registers - including annual influenza vaccination and pneumococcal vaccination.

6. Promote elimination of *in utero* smoke exposure and exposure of children to environmental tobacco and wood smoke.

B. Recommendations Specific to Management of Bronchiectasis

1. Strengthen primary care services (particularly outreach into the community and especially resources for chest physiotherapy) to recognise symptoms of bronchiectasis and manage exacerbations according to current standards [59] (e.g. increased chest physiotherapy and pro-

longed, 2-6 weeks, courses of antibiotics for exacerbations).

2. Low threshold for referral from primary care for investigation of bronchiectasis in children with recurrent lower respiratory tract infection and/or chronic moist cough. For example, in a child with persistent wet cough for greater than 4 weeks, the features we believe should indicate more aggressive ascertainment of a definitive diagnosis would be:
   - repeated (> 3 in one year) antibiotic courses with only partial or temporary resolution of symptoms
   - persisting chest X-Ray changes
   - two or more definite episodes of pneumonia requiring hospital admission
   - referral from hospital or community paediatricians [67]
   - recurrent protracted bronchitis [68]
3. Routine follow up of children after severe respiratory illness secondary to specific organisms especially vaccine preventable diseases, such as measles or pertussis, but also TB and adenovirus.
4. Complete investigations in those diagnosed with bronchiectasis to identify treatable causes.
5. Look for and manage co-morbidities and complications of bronchiectasis.
6. Adoption of a standard abbreviation e.g. 'BX' may allow a more immediate recognition - similar to 'CF' - than is currently the case.
7. Provide sufficient resources to enable a multidisciplinary approach akin to the CF model.

RESEARCH INITIATIVES NEEDED

Large gaps of knowledge persist in our understanding of indigenous bronchiectasis disease. Further collaborative international research is necessary to guide future management. Research is needed in the following areas:

a. What are the aetiological factors and early determinants of bronchiectasis in indigenous peoples?
b. How large are the influences of each of the suspected risk factors?
c. What determines the heterogeneity of bronchiectasis disease?
d. Does chronic nasopharyngeal carriage of pathogenic bacteria contribute to indigenous bronchiectasis?
e. Intervention studies to determine which is the best antibiotic, the strategy, timing and duration of antibiotic treatment.
f. How effective are current practices? Qualitative research involving indigenous children and adults with bronchiectasis outlining their experience of health services for their condition and how improvements can be implemented.
g. Does early management in those with minimal disease lead to preservation of the lung structure and function?
h. What are the best outcome measures in young children with indigenous bronchiectasis and how are they best achieved in these populations?

SUMMARY STATEMENT

Bronchiectasis appears common in indigenous communities around the world, as described in Alaska, Australia

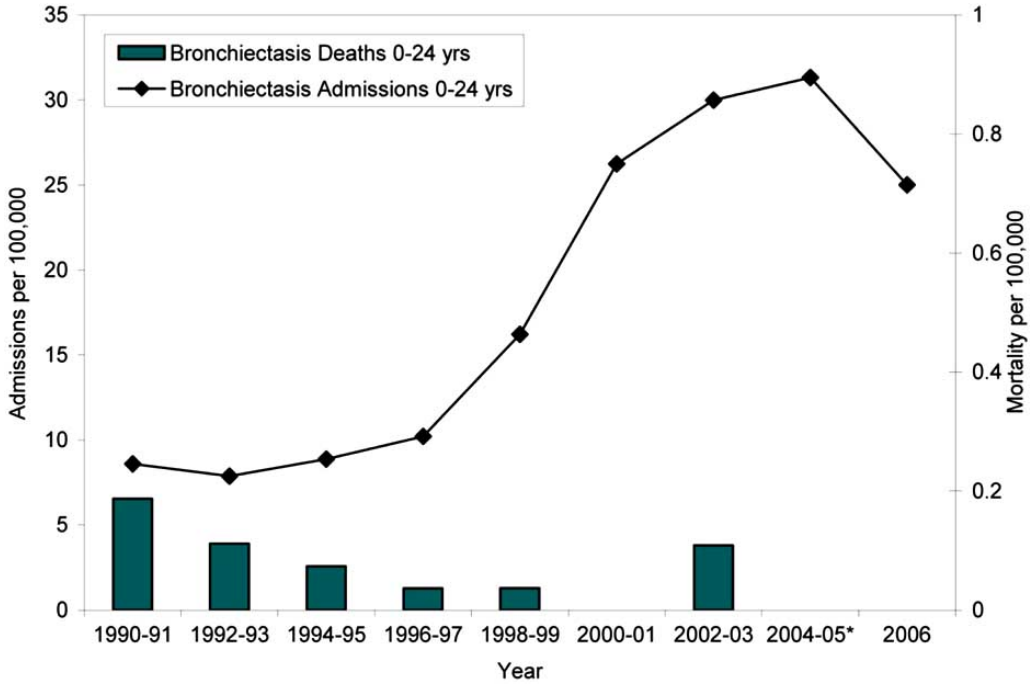

Fig. (1). Hospital admissions and deaths

Hospital admissions and Deaths due to Bronchiectasis in Children and Young People 0-24 Years, New Zealand 1990-2006 (Admissions and 1990-2004 Deaths) *(provided by NZ Child & Youth Epidemiology Service 2006, Dr. Elizabeth Craig).*

and NZ. In order to reduce the burden of bronchiectasis, we need to increase the awareness of the presence and the management strategy for chronic wet/productive cough. We need to promote a change in terminology to aid standardisation of diagnosis, management and a minimum expectation of care across countries. Health care approaches need to involve these communities in developing culturally knowledgeable services and to be open to adopting strategies that work within these populations to aid early and improved access to care and engagement with treatment. Since the late 1990s Alaska Native people have received health care through tribally-run facilities and program which incorporate these strategies. Paediatricians need to partner with indigenous programs to improve immunisation rates, reduce known risk factors such as tobacco smoke exposure, recognise risk factors for development of bronchiectasis and have clearly defined access to appropriate medical care.

ACKNOWLEDGEMENTS

We would like to thank Ms. Lorraine Hetaraka-Stevens and Ms. Hilda Fa'asalele for their collaboration and advice on Māori and Pacific Peoples cultural issues and the Alaska Native Tribal Health Consortium in writing this manuscript.

ABBREVIATIONS

AN	=	Alaskan Native
BX	=	Bronchiectasis
CF	=	Cystic Fibrosis
CSLD	=	Chronic suppurative lung disease
FEV_1	=	Forced Expiratory Volume in 1 Second
HI	=	*Haemophilus influenzae*
HRCT	=	High Resolution Computed Tomography
LRTI	=	Lower Respiratory Tract Infection
NZ	=	New Zealand
PCD	=	Primary Ciliary Dyskinesia
RSV	=	Respiratory Syncytial Virus
TB	=	Tuberculosis
UK	=	United Kingdom
WHO	=	World Health Organisation
YK	=	Yukon-Kuskokwim

REFERENCES

[1] Kolbe J, Wells AU. Bronchiectasis: A neglected cause of respiratory morbidity and mortality. Respirology 1996; 1(4): 221-5.

[2] Ministry of Health. The Health of Pacific Island People. New Zealand Wellington, 1994.

[3] Chang AB, Masel JP, Boyce NC, Wheaton G, Torzillo PJ. Non-CF bronchiectasis: Clinical and HRCT evaluation. Pediatr Pulmonol 2003; 35(6): 477-83.

[4] Edwards EA, Asher MI, Byrnes CA. Paediatric bronchiectasis in the twenty-first century: Experience of a tertiary children's hospital in New Zealand. J Paediatr Child Health 2003; 39(2): 111-7.

[5] Twiss J, Metcalfe R, Edwards E, Byrnes C. New Zealand national incidence of bronchiectasis "too high" for a developed country. Arch Dis Child 2005; 90(7): 737-40.

[6] Singleton R, Morris A, Redding G, *et al*. Bronchiectasis in Alaska native children: Causes and clinical courses. Pediatr Pulmonol 2000; 29(3): 182-7.

[7] Thomas DR. Assessing ethnicity in New Zealand health research. NZ Med J 2001; 114(1127): 86-8.

[8] Fleshman JK, Wilson JF, Cohen JJ. Bronchiectasis in Alaska native children. Arch Environ Health 1968; 17(4): 517-23.

[9] Nikolaizik WH, Warner JO. Aetiology of chronic suppurative lung disease. Arch Dis Child 1994; 70(2): 141-2.

[10] Redding G, Singleton R, Lewis T, *et al*. Early radiographic and clinical features associated with bronchiectasis in children. Pediatr Pulmonol 2004; 37(4): 297-304.

[11] d'Espainet ET KK, Paterson BA, Measey ML. From infancy to young adulthood: Health status in the northern territory. Darwin, Australia: Territory Health Services 1998.

[12] Mortality of Aboriginal and Torres Straits Islander Australians: Australian Bureau of Statistics 2000.

[13] National summary of the 2003 & 2004 jurisdictional reports against the Aboriginal and Torres Strait Islander health performance indicators: Australian Institute of Health and Welfare 2006.

[14] Occasional Paper. Hospital Statistics-Mortality of Aboriginal and Torres Strait Islander Australians 2002.

[15] Aboriginal and Torres Straits Islander Health Survey: Australian Bureau of Statistics 2006.

[16] Chang AB, Boyce NC, Masters IB, Torzillo PJ, Masel JP. Bronchoscopic findings in children with non-cystic fibrosis chronic suppurative lung disease. Thorax 2002; 57(11): 935-8.

[17] Steinfort DP, Brady S, Weisinger HS, Einsiedel L. Bronchiectasis in Central Australia: a young face to an old disease. Respir Med 2008; 102(4): 574-8.

[18] Valery PC, Torzillo PJ, Mulholland K, Boyce NC, Purdie DM, Chang AB. Hospital-based case-control study of bronchiectasis in indigenous children in Central Australia. Pediatr Infect Dis J 2004; 23(10): 902-8.

[19] Hinds JR. Bronchiectasis in Maori. N Z Med J 1958; 57: 328-32.

[20] Saynajakangas O, Keistinen T, Tuuponen T, Kivela SL. Bronchiectasis in Finland: trends in hospital treatment. Respir Med 1997; 91(7): 395-8.

[21] Edwards EA, Metcalfe R, Milne DG, Thompson J, Byrnes CA. Retrospective review of children presenting with non cystic fibrosis bronchiectasis: HRCT features and clinical relationships. Pediatr Pulmonol 2003; 36(2): 87-93.

[22] Becroft DM. Histopathology of fatal adenovirus infection of the respiratory tract in young children. J Clin Pathol 1967; 20(4): 561-9.

[23] Becroft DM. Bronchiolitis obliterans, bronchiectasis, and other sequelae of adenovirus type 21 infection in young children. J Clin Pathol 1971; 24(1): 72-82.

[24] Becroft DM. Pulmonary sequelae of epidemic type 21-adenovirus infection: a 13-year follow-up. Arch Dis Child 1979; 54: 155-6.

[25] Waite D, Wakefield JS, Steele R, Mackay J, Ross I, Wallace J. Cilia and sperm tail abnormalities in Polynesian bronchiectatics. Lancet 1978; 2(8081): 132-3.

[26] Wakefield S, Waite D. Abnormal cilia in Polynesians with bronchiectasis. Am Rev Respir Dis 1980; 121(6): 1003-10.

[27] Waite DA, Wakefield SJ, Mackay JB, Ross IT. Mucociliary transport and ultrastructural abnormalities in Polynesian bronchiectasis. Chest 1981; 80(6 Suppl): 896-8.

[28] Waite DA, Wakefield SJ, Moriarty KM, Lewis ME, Cuttance PC, Scott AG. Polynesian bronchiectasis. Eur J Respir Dis Suppl 1983; 127: 31-6.

[29] Edwards EA, Douglas C, Broome S, *et al*. Nitric oxide levels and ciliary beat frequency in indigenous New Zealand children. Pediatr Pulmonol 2005; 39(3): 238-46.

[30] Twiss J, Stewart AW, Byrnes CA. Longitudinal pulmonary function of childhood bronchiectasis and comparison with cystic fibrosis. Thorax 2006; 61(5): 414-8.

[31] Chang AB, Grimwood K, Mulholland EK, Torzillo PJ. Working group on indigenous paediatric respiratory. Bronchiectasis in indigenous children in remote Australian communities. Med J Aust 2002; 177(4): 200-4.

[32] Grant CC, Wall CR, Brunt D, Crengle S, Scragg R. Population prevalence and risk factors for iron deficiency in Auckland, New Zealand. J Paediatr Child Health 2007; 43(7-8): 532-8.

[33] Wood L, Santibanez T, Barker L, Singelton R. Vaccination coverage levels among Alaska native children aged 19-35 months –

National Immunization Survey: United States, 2000-2001. Morb Mortal Wkly Rep 2003; 52(30): 710-3.
[34] Relationship between In-Home Water Service and Lower Respiratory Infections - Alaska 1999-2002. State of Alaska: Department of Health and Human Services 2007.
[35] Grant CC, Scragg R, Tan D, Pati A, Aickin R, Yee RL. Hospitalization for pneumonia in children in Auckland, New Zealand. J Paediatr Child Health 1998; 34(4): 355-9.
[36] Chang AB, Masel JP, Boyce NC, Torzillo PJ. Respiratory morbidity in central Australian Aboriginal children with alveolar lobar abnormalities. Med J Austr 2003; 178(10): 490-4.
[37] Field CE. Bronchiectasis in childhood; Clinical survey of 160 cases. Pediatrics 1949; 4(1): 21-46.
[38] Field CE. Bronchiectasis. Third report on a follow-up study of medical and surgical cases from childhood. Arch Dis Child 1969; 44(237): 551-61.
[39] Ip M, Lam WK, So SY, Liong E, Chan CY, Tse KM. Analysis of factors associated with bronchial hyperreactivity to methacholine in bronchiectasis. Lung 1991; 169(1): 43-51.
[40] Ip MS, So SY, Lam WK, Yam L, Liong E. High prevalence of asthma in patients with bronchiectasis in Hong Kong. Eur Respir J 1992; 5(4): 418-23.
[41] Bahous J, Cartier A, Pineau L, *et al*. Pulmonary function tests and airway responsiveness to methacholine in chronic bronchiectasis of the adult. Bull Eur Physiopathol Respir 1984; 20(4): 375-80.
[42] Varpela E, Laitinen LA, Keskinen H, Korhola O. Asthma, allergy and bronchial hyper-reactivity to histamine in patients with bronchiectasis. Clin Allergy 1978; 8(3): 273-80.
[43] Singleton RJ, Redding GJ, Lewis TC, *et al*. Sequelae of severe respiratory syncytial virus infection in infancy and early childhood among Alaska Native children. Pediatrics 2003; 112(2): 285-90.
[44] Karakoc GB, Yilmaz M, Altintas DU, Kendirli SG. Bronchiectasis: Still a problem. Pediatr Pulmonol 2001; 32(2): 175-8.
[45] Karadag B, Karakoc F, Ersu R, Kut A, Bakac S, Dagli E. Non-cystic-fibrosis bronchiectasis in children: a persisting problem in developing countries. Respiration 2005; 72(3): 233-8.
[46] Karakoc FDEGI, Bakac S, Yuksal M, Kiyan G, Dagli TE. The outcome and long-term follow-up of children wth bronchiectasis. Eur Respir J 1997; 10: 171S. (Abstract only).
[47] Watson K, Carville K, Bowman J, *et al*. Upper respiratory tract bacterial carriage in Aboriginal and non-Aboriginal children in a semi-arid area of Western Australia. Pediatr Infect Dis J 2006; 25(9): 782-90.
[48] Leach AJ. Otitis media in Australian aboriginal children: An overview. Int J Pediatr Otorhinolaryngol 1999; 49(Suppl 1): S173-8.
[49] Gursel G. Does coexistence with bronchiectasis influence intensive care unit outcome in patients with chronic obstructive pulmonary disease? Heart Lung 2006; 35(1): 58-65.
[50] Patel IS, Vlahos I, Wilkinson TM, *et al*. Bronchiectasis, exacerbation indices, and inflammation in chronic obstructive pulmonary disease. Am J Respir Crit Care Med 2004; 170(4): 400-7.
[51] Eastham KM, Fall AJ, Mitchell L, Spencer DA. The need to redefine non-cystic fibrosis bronchiectasis in childhood. Thorax 2004; 59(4): 324-7.
[52] Tsao PC, Lin CY. Clinical spectrum of bronchiectasis in children. Acta Paediatrica Taiwanica 2002; 43(5): 271-5.
[53] Lai SH, Wong KS, Liao SL. Clinical analysis of bronchiectasis in Taiwanese children. Chang Gung Med J 2004; 27(2): 122-8.
[54] Li AM, Sonnappa S, Lex C, *et al*. Non-CF bronchiectasis: Does knowing the aetiology lead to changes in management?[see comment]. Eur Respir J 2005; 26(1): 8-14.
[55] Gaillard EA, Carty H, Heaf D, Smyth RL. Reversible bronchial dilatation in children: Comparison of serial high-resolution computer tomography scans of the lungs. Eur J Radiol 2003; 47(3): 215-20.
[56] Mansour Y, Beck R, Danino J, Bentur L. Resolution of severe bronchiectasis after removal of long-standing retained foreign body. Pediatr Pulmonol 1998; 25(2): 130-2.
[57] Rosen MJ. Chronic cough due to bronchiectasis: ACCP evidence-based clinical practice guidelines. Chest 2006; 129(1 Suppl): 122S-31S.
[58] Edwards EA, Twiss J, Byrnes CA. Treatment of paediatric non-cystic fibrosis bronchiectasis. Expert Opin Pharmacother 2004; 5(7): 1471-84.
[59] Chang AB, Grimwood K, Mulholland EK, Torzillo PJ. Bronchiectasis in indigenous children in remote Australian communities. Med J Austr 2002; 177: 200-4.
[60] Kerem E, Conway S, Elborn S, Heijerman H, Consensus C. Standards of care for patients with cystic fibrosis: a European consensus. J Cyst Fibros 2005; 4(1): 7-26.
[61] Bush A, Cole P, Hariri M, *et al*. Primary ciliary dyskinesia: Diagnosis and standards of care. Eur Respir J 1998; 12(4): 982-8.
[62] Chang AB, Landau LI, Van Asperen PP, *et al*. Cough in children: Definitions and clinical evaluation. Med J Austr 2006; 184(8): 398-403.
[63] Pink R. Bronchiectasis: disease of the impoverished? [Masters thesis]. Christchurch School of Medicine: University of Otago 2004.
[64] Durie M. Providing health services to indigenous peoples. BMJ 2003; 327(7412): 408-9.
[65] Chang AB, Taylor B, Masters IB, Laifoo Y, Brown AD. Indigenous healthcare worker involvement for Indigenous adults and children with asthma. Cochrane Database Syst Rev 2007; (4): CD006344.
[66] Bailey EJM, Kruske PS, Cates S, Chang AB. Culture-specific programms for children and adults from minority groups who have asthma. Cochrane Database Syst Rev 2008(2).
[67] Byrnes CAE. Outcomes in children treated for persistent bacterial bronchitis. Thorax 2007; 62: 80-4.
[68] Chang AB, Redding GJ, Everard ML. Chronic wet cough: Protracted bronchitis, chronic suppurative lung disease and bronchiectasis. Pediatr Pulmonol 2008; 43(6): 519-31.

Received: 18 August, 2009 Revised: 03 December, 2009 Accepted: 08 December, 2009