Respiratory morbidity in central Australian Aboriginal children with alveolar lobar abnormalities

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ABSTRACT

Objectives: To describe the short-term outcomes in Aboriginal children admitted to hospital with radiological alveolar lobar changes; and determine whether predischarge chest radiography can predict respiratory morbidity found at follow-up.

Design, participants, setting: Prospective cohort study of Aboriginal children admitted to Alice Springs Hospital between October 2000 and April 2001 with alveolar lobar abnormalities (area of consolidation, $\geqslant$ 1 cm) on chest radiographs. Participants were to have a predischarge radiograph and be followed up for 12 months.

Main outcome measures: Comorbidities, follow-up rate, and new respiratory disease found at follow-up.

Results: Of 113 children hospitalised with radiological alveolar lobar changes, 109 were Aboriginal. Their median age was 1.8 years (range, 0.2 months–13.3 years), and 124 episodes were recorded. Comorbidities were common in these children (anaemia, 51.5%; suppurative otitis media, 37.3%). The follow-up rate one year after admission was 83.1% of episodes. New treatable chronic respiratory morbidity was found in 20 (25.6%) of the 78 children with completed follow-up. Predischarge chest radiographs were predictive of all chronic respiratory morbidity when they showed no or minimal resolution (0–20% resolution) (relative risk, 7.43; 95% CI, 2.07–26.60).

Conclusions: Central Australian Aboriginal children admitted to hospital with alveolar changes on chest radiographs have a substantial burden of chronic respiratory illness, and should be clinically followed up for early detection and management of chronic respiratory morbidity. A predischarge radiograph is useful, and patients whose radiograph shows no or minimal resolution should have a follow-up x-ray film.

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THE MOST SEVERELY disadvantaged population group in Australia are remote-dwelling Aboriginals and Torres Strait Islanders.[1] Their age distribution[2] and the illness patterns in their children resemble those in developing countries. In the Northern Territory, the Australian State with the highest proportion of Aboriginal people,[2] respiratory illness is the most common hospital separation diagnosis in infants and children aged 1–5 years,[3] and accounts for 15.2% of all hospital admissions of Aboriginals (the highest category after childbirth and pregnancy).[2] However, these data under-represent the true burden of acute respiratory disease, as many of the children with pneumonia are treated in their remote communities.

There are no data to quantify respiratory morbidity after hospitalisation for acute pneumonia in this population. Respiratory illness in childhood is a risk factor for chronic respiratory morbidity and pulmonary dysfunction in adulthood,[4] and childhood pneumonia is a risk factor for bronchiectasis later in life. There is an unacceptably high rate of chronic suppurative lung disease in Aboriginal children living in remote communities.[5,6]

A follow-up chest radiograph in patients with pneumonia can detect other pulmonary disease and hence determine appropriate management.[7] However, the use of chest radiography in uncomplicated pneumonia (and particularly the need for a follow-up x-ray film) has been debated.[8] Canadian guidelines for management of pneumonia in children encourage the use of chest radiography,[9,10] but UK guidelines discourage its use.[10] Published Australian paediatric guidelines do not exist as yet, but it is common practice for children hospitalised in Australian paediatric centres to have an initial and follow-up chest radiograph.

For children in remote communities, a follow-up chest radiograph often involves a plane flight, overnight accommodation, major disruption to family life and high costs. If a predischarge chest radiograph could predict ongoing respiratory morbidity, this could potentially reduce the economic and social costs associated with following up all children.

The aim of our study was to assess follow-up respiratory care by (i) evaluating short-term outcomes, and (ii) determining whether a predischarge chest radiograph can predict respiratory morbidity of children hospitalised with alveolar lobar changes on a chest radiograph.

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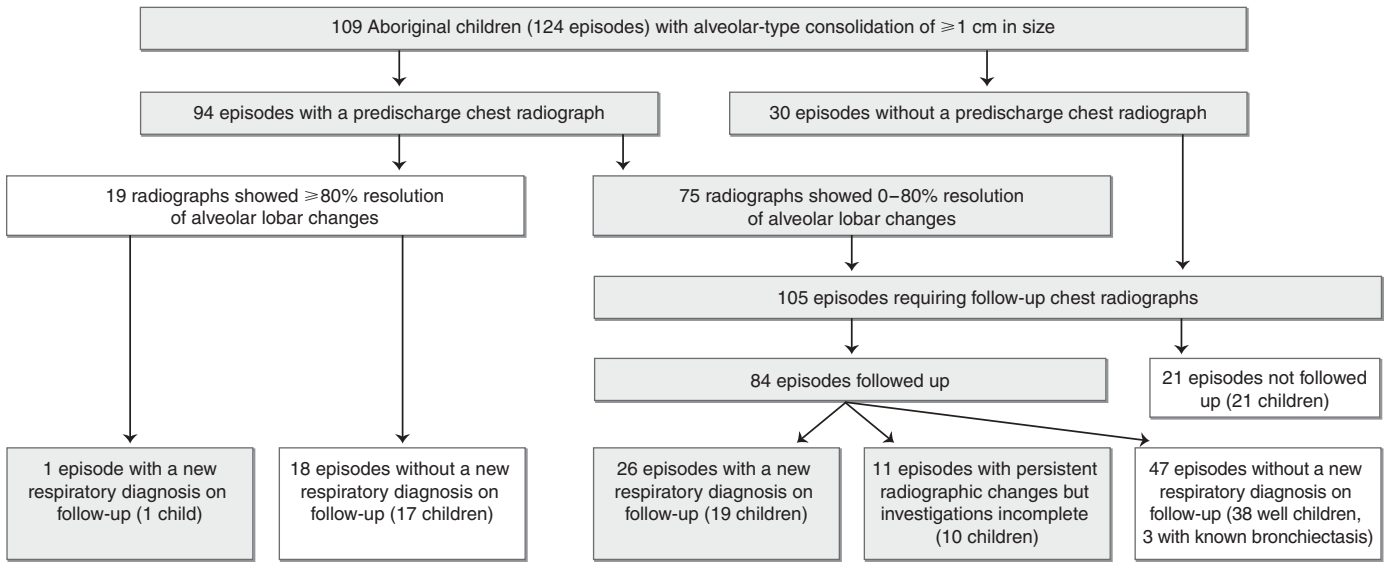
METHODS

Setting

Alice Springs Hospital is the only hospital in Alice Springs (population, 27 629)

1: Flowchart of outcomes of children in the study



and the central Australian region, covering an area of about one million km^2. Aboriginal Australians account for about a third of the population of central Australia,[3] and most live in small, remote communities.

Inclusion criteria

The radiographs of all children admitted to Alice Springs Hospital during a 6-month period (October 2000 to April 2001) were reviewed prospectively by a respiratory paediatrician (A B C). Irrespective of the admission diagnosis, children were included in the study if the x-ray film revealed alveolar-type consolidation measuring ⩾ 1 cm. Demographic data for that child were then collected. Excluded were children with clinical aspiration pneumonia or severe neurological impairment. Definitions of alveolar consolidation and radiological change were defined *a priori* for our study, as there were no suitable published systems for our objectives.

Study procedure

The children were followed up for a period of 12 months from presentation, with examination of their medical records and chest radiographs. All radiographs and chest high-resolution computed tomography (CT) scans were sent to a paediatric radiologist (J P M), who was blinded to the child's clinical status. While inter-rater reliability can be an issue, access to a second paediatric radiologist to assess the radiographs was not possible at Alice Springs Hospital. A predischarge chest radiograph was performed before, or on the day of, discharge, and was compared with the admission radiograph.

Follow-up

Standard hospital protocol required all children to have a clinical and radiological follow-up within 2 months of discharge. Children who had not been followed up when their medical records were reviewed were contacted and given an appointment. A respiratory physician reviewed children with persistent radiographic changes at follow-up. Chest CT was performed when persistent radiographic changes were accompanied by persistent respiratory symptoms of cough, exertional dyspnoea or abnormal clinical signs.

Terms and definitions

Radiological changes

"Minimal" resolution (of the alveolar lobar changes): 0–20%;
"Moderate" resolution: 20%–80%; and
"Near-complete" resolution: 80%–100%.

Respiratory tract diagnoses

A new diagnosis: the child had not previously been diagnosed with the condition at the index presentation.
Reactive airways disease: the child had recurrent wheezing that reversed with β_2-agonist therapy.
Bronchiectasis: chest CT scans in the absence of acute illness showed the changes of bronchiectasis according to the criteria of Naidich et al.[11]
Chronic suppurative lung disease: the child had a prolonged (> 4 months) history of productive and/or moist cough that responded to intravenous antibiotic treatment, but a chest CT scan did not show the changes of bronchiectasis.

Follow-up status

Not required: total resolution of lobar abnormalities on predischarge chest radiography.
Opportunistic: follow-up evaluation during an unrelated consultation or hospitalisation.
Successful: child seen within 2 months of acute presentation, if follow-up was required.
Unsuccessful: child not seen within 2 months of acute presentation, if follow-up was required.
Not completed: children who were followed up for respiratory symptoms with persistent radiological changes, but respiratory investigations were incomplete at time of study conclusion.

2: Characteristics of 109 Aboriginal children, admitted to hospital over a 6-month period, who had alveolar lobar abnormalities (124 episodes)

Variable	Median (range) or number (%)
Patient characteristics ($n = 109$)	
Sex (M : F)	68 : 41
Number with weight for age *z* score less than –2SD	15 (13.8%)
Median weight for age *z* score	–0.88 (–3.15, 2.58)
Median height for age *z* score	–0.63 (–4.30, 6.80)
Median weight for height *z* score	–0.48 (–3.80, 2.26)
Gestation at birth	
Number at term (> 37 weeks)	86 (78.9%)
Number preterm (30–36 weeks)	12 (11.0%)
Number preterm (24–29 weeks)	1 (0.9%)
Unknown	10 (9.2%)
Median birthweight (kg)	3.19 (0.79, 3.24)
Number with known bronchiectasis	3 (2.7%)
Number with a mother who smoked (excludes pitjuri [traditional tobacco] chewing)	21 (19.3%)
Episode characteristics ($n = 124$)	
Patient's median age (years)	1.78 (0.02, 13.30)
Number collected by Royal Flying Doctor Service	63 (50.8%)
Median duration of hospitalisation (days)	5 (2, 48)
Number requiring oxygen therapy	32 (25.8%)
Median length of time oxygen required (hours)	0 (0, 168)
Number given prior antibiotics	48 (38.7%)
Median neutrophil count ($x10^9$/L)	13.1 (1.5, 44.2)
Median time taken for temperature to return to normal (hours)	0 (0, 120)
Number with comorbidities	
Anaemia	64 (51.5%)
Chronic suppurative otitis media	45 (36.3%)
Diarrhoea	37 (29.8%)
Urinary tract infection	2 (1.6%)
Median number of previous admissions	2 (0–21)
Median time since last admission (years)	0.52 (0, 9)
Number with previous admission for bronchiolitis	54 (43.5%)
Number with previous admission for pneumonia	69 (55.6%)

Ethical approval

The Central Australian Human Ethics Committee approved the study and written consent was obtained from a parent or carer for each child.

Statistical analysis

Data were analysed using the Statistical Package for the Social Sciences (SPSS).[12] Groups were compared using the Mann–Whitney test, and 2-tailed *P* levels less than 0.05 were considered significant. Relative risks were calculated according to Altman.[13] For calculation of weight and height *z* scores, data based on the World Health Organization growth reference[14] were used.

RESULTS

Study cohort

Over the 6-month period, 1002 paediatric separations were recorded (763 Aboriginal, 239 non-Aboriginal), with a respiratory condition as the principal diagnosis in 381. The radiological criteria were fulfilled in 136, but eight episodes were excluded (severe neurological illness or aspiration-like event in five, no consent in three), leaving 128 episodes for inclusion in the study. These 128 episodes occurred in 113 children, as 14 children had recurrent admissions (13 children with two admissions and one child with three admissions). Four children (single episodes) were not Aboriginal and, given the small number, were omitted from the follow-up data. Data were analysed for number of episodes ($n = 124$) or number of children ($n = 109$). A flowchart of the outcomes for the 109 children in our study is given in Box 1.

Comorbidities were common (Box 2), as was previous hospitalisation for respiratory infections (71% of episodes). In 112 episodes (90.3%), respiratory illness was the primary reason for admission; in the remainder, the reasons for admission were gastroenteritis (7; 5.6%), febrile convulsion (2; 1.6%), and one each (0.8%) surgery, abdominal pain, and "failure to thrive". None of the children who had recurrent admissions were previously known to have had bronchiectasis.

Treatment

Intravenous penicillin (standard treatment for pneumonia in Alice Springs Hospital) was used in 95 episodes (76.6%). Other antibiotics used as the first antibiotic were cefotaxime in 17 episodes, and ampicillin in five. In 37 episodes, a second antibiotic was given (cefotaxime in four, flucloxacillin in 16, gentamicin in 15, vancomycin in two), and in one episode oral antibiotics were prescribed on discharge.

Investigations

For all episodes, blood cultures were done, but the results were positive in only two (*Streptococcus pneumoniae* in both). Nasopharyngeal aspirate, sputum cultures or serological tests for mycoplasma were performed for 48 episodes, yielding a positive result for one organism in 10 episodes and for two organisms in four episodes (*Haemophilus influenzae* in five, *S. pneumoniae* in two, respiratory syncytial virus in three, *Mycoplasma pneumoniae*-positive IgM

3: Follow-up respiratory diagnoses in the 78 children whose follow-up was completed*

Respiratory diagnosis at follow-up	No. of children
No respiratory morbidity documented	55
Bronchiectasis	
New diagnosis	9
Previously diagnosed	3
Chronic suppurative lung disease	5
Reactive airway disease	5 (2)†
Pulmonary abscess	1
Bronchiolitis obliterans	0 (1)†

* At least one new diagnosis was found in 20 of the 78 children (25.6%) with follow-up completed.
† Three of these 20 children had a second respiratory condition diagnosed.

serology in two, adenovirus in three, influenza virus in three). There was no significant difference in the number of new respiratory diagnoses on follow-up between those who did and did not have these three tests ($P = 0.6$)

Lumbar puncture was performed in 17 episodes (13.7%), with a positive yield in two (11.8% of lumbar punctures). Urine microscopy was performed in 83 episodes, and in 17 of these a second urine test was done. A urinary tract infection was diagnosed in two episodes.

Follow-up

A predischarge chest radiograph was available in only 94 episodes (75.8%). "Complete" resolution was present in 19 episodes (15.3%). A follow-up radiograph was required in the remaining 105 episodes (Box 1). Of these, only 33 episodes (31.4%) had a "successful" follow-up (follow-up within 2 months). The two most common reasons were no appointment requested by the junior doctors, as detailed in the discharge summary (38 episodes), and the child not attending the appointment (21 episodes).

Within a year after the acute admission, follow-up occurred (84 episodes) or was no longer required (19 episodes with "near-complete" resolution on the predischarge radiograph) for a total of 103 episodes (83.1%), with "opportunistic" follow-up occurring in 38 episodes. However, not all children had their respiratory follow-up completed within the study period, as 10 children (11 episodes) were still being evaluated for persistent symptoms accompanied by radiological changes (Box 1). Respiratory diagnoses in the 78 children in whom follow-up was completed are shown in Box 3.

Predictive value of predischarge radiographic findings

- 10 of the 14 children with new bronchiectasis or chronic suppurative lung disease had a predischarge chest radiograph. "Minimal" radiographic resolution occurred in four.
- 14 of the 22 children with any respiratory morbidity at follow-up had a predischarge chest radiograph. "Minimal" radiographic resolution occurred in six.
- 52 of the 58 children without any new respiratory morbidity on follow-up, had a predischarge chest radiograph. "Minimal" radiographic resolution occurred in three, and "near-complete" radiographic resolution in 15.

The relative risk of having bronchiectasis or chronic suppurative lung disease when the predischarge radiograph showed "minimal" resolution was 6.93 (95% CI, 1.78–26.60). The relative risk of all respiratory morbidity when the predischarge radiograph showed "minimal" resolution was 7.43 (95% CI, 2.07–26.60). When the predischarge chest radiograph showed "near-complete" resolution, the relative risk of having bronchiectasis or chronic suppurative lung disease was 0.35 (95% CI, 0.05–2.42). When all respiratory morbidity was combined (chest radiograph showed "complete" resolution), the respective relative risk was 0.50 (95% CI, 0.12–1.96).

DISCUSSION

Our study showed that Aboriginal children admitted to hospital have a high burden of previous respiratory illness and comorbidities. Of the children with completed follow-up, a new treatable respiratory condition was found in 25.6% within 12 months of their index illness. When the predischarge chest radiograph showed "minimal" resolution, there was a high likelihood of chronic respiratory disease being detected at the subsequent follow-up, although our results should be interpreted with caution, given the wide confidence intervals.

Aetiology and carriage studies have been performed in central Australian Aboriginal children with acute lower respiratory infection,[15,16] but there are no published clinical follow-up data. In contrast to the situation in developing countries, morbidity rather than mortality is the major concern in children with acute lower respiratory infections in disadvantaged communities living in affluent countries.[17]

Although our eventual follow-up rate of 83.1% of episodes (with extra effort being made for our study) was acceptable, the follow-up rate at 2 months was low at 31.4%. This, combined with the high rate (25.6%) of respiratory morbidity in children followed up, strongly suggests that an appropriate program to improve respiratory and other ambulatory services would be beneficial for the early diagnosis and appropriate management of these children. Even if it is assumed that the 21 children lost to follow-up did not have any respiratory morbidity, the proportion of children with new respiratory morbidity is still high at 22.7% (20 of 88 children).

To our knowledge, this is the first study to document the need for vigilant follow-up of Indigenous children hospitalised with lobar alveolar changes. There are several possible reasons for the high rates of disease found on follow-up.

Firstly, we suspect that many of the radiological changes noted were chronic rather than acute. Other disadvantaged groups in affluent countries, such as Alaskan Inuit children in the United States,[18] also have high levels of chronic respiratory morbidity, as do children in developing countries.

Secondly, Aboriginal children living in remote communities have high rates of purulent nasal and ear discharge,[19] as well as dense nasopharyngeal colonisation with respiratory pathogens.[16] Microaspiration of these secretions may contribute not just to high rates of lower respiratory infections, but also to the

prevalence of chronic suppurative lung disease.

Thirdly, an increased risk of lower respiratory infections is associated with a greater number of house occupants, poor quality housing, macro- and micromalnutrition, inadequate water supply, and exposure to biomass combustion and tobacco smoke, conditions which apply to many remote Indigenous communities.[20] These conditions may also contribute to incomplete resolution of lower respiratory tract infections.

A critical question for future research is whether treatment with antibiotics for 5 days is inadequate, resulting in persistent low-grade bacterial bronchitis. It is possible that, as described by Cole,[21] incomplete eradication of bacteria in early bacterial pneumonia, as well as persistent airway inflammation, promotes the development of bronchiectasis.

In ambulatory settings, chest radiographs have limited value in acute respiratory infections.[22] Guideline recommendations against using predischarge and repeat chest radiographs are based generally on Level D evidence (expert opinion or a lower evidence level).[9] Our prospective study is limited by a small numbers of subjects. However, children whose predischarge chest radiograph showed "minimal" resolution of changes appeared to have a significantly increased risk of bronchiectasis, chronic suppurative lung disease, and other respiratory morbidity, on follow-up within 12 months of their index illness. However, the risk was not reduced when "near-complete" resolution occurred. The lack of a predictive value of "near-complete" resolution may relate to the short-term nature of the study, as subsequent respiratory infections, rather than the index illness, could influence the development of chronic suppurative lung disease. A predischarge chest radiograph, if predictive of morbidity, would indeed be highly beneficial in remote or rural settings. The question of whether delayed clearing predicts bronchiectasis or new respiratory morbidity cannot be answered from our study, as repeated timed chest radiographs could not be done in our setting. For the otherwise well child, follow-up radiographs are not recommended, but such recommendations may be inappropriate for central Australian Aboriginal children, as many have recurrent pneumonia, comorbidities and socioeconomically poor living conditions. Clinical predictors (other than malnutrition and exposure to pollutants) for the development of chronic respiratory morbidity, not identifiable in this limited study, would be beneficial in determining which children need radiological follow-up.

Until further studies are performed our findings suggest that, in our setting, all children with alveolar lobar radiological abnormalities should be followed up clinically, and those with persistent symptoms, or whose predischarge chest radiograph shows "minimal" resolution, should also have a follow-up chest radiograph. There is an urgent need to reduce lower respiratory infections and to determine better means of preventing long-term respiratory complications in such populations.

COMPETING INTERESTS

None identified.

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Correction

Re: Injecting drug use in Australia: needle/syringe programs prove their worth, but hepatitis C still on the increase, by Law MG and Batey RG in the 3 March 2003 issue of the Journal (*Med J Aust* 2003; 178: 197-198). Dr Batey's position was incorrectly given as Director, Gastroenterology Department, John Hunter Hospital. His position is Clinical Chair, Division of Medicine, John Hunter Hospital. ❑