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Household characteristics of children under 2 years admitted with lower respiratory tract infection in Counties Manukau, South Auckland

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Abstract

Aim To describe household characteristics of admissions for lower respiratory tract infection (LRI) in children aged less than 2 years in Counties Manukau, South Auckland, New Zealand.

Methods Prospective recruitment of all children aged less than 2 years admitted with a primary diagnosis of LRI from August to December 2007 with caregiver questionnaire.

Results There were 580 admissions involving 465 children, 394 of whom had completed questionnaires (85% response rate). Sixty-four percent of admissions had a diagnosis of bronchiolitis and 26% of pneumonia. Relative risk of admission was 4.4 (95% CI 3.2–6.2) for Māori, 5.8 (4.4–7.9) for Pacific peoples compared with European/others and 3.1 (2.4–3.9) for the most deprived quintile compared with other quintiles. Longer total stay was more likely in those of younger age, who were premature or of Māori or Pacific ethnicity. Household characteristics demonstrate that 25% live with ≥7 other people, 33% live with 4 or more children, 65% of children are exposed to cigarette smoke and 27% use no form of heating.

Conclusions Among young children admitted with LRI there is a high rate of exposure to known avoidable risk factors such as smoking, lack of heating and large households in overcrowded conditions.

Internationally lower respiratory infection (LRI) is a major cause of hospital admission in young children. Admissions for LRI have been increasing over the late 1990s and early 2000s in developed countries.[1–3]

New Zealand has high rates of admissions for LRI and these admissions are concentrated in Māori and Pacific and in areas of high deprivation. Counties Manukau District Health Board (DHB) has the highest rate of admission for childhood LRI of any DHB in New Zealand.[4]

LRI has been identified as a more useful epidemiologic and clinical description than differentiating between bronchiolitis and pneumonia, as there is significant variation in diagnosis and interpretation of chest X-ray with considerable proportions of children with a discharge diagnosis of bronchiolitis being found to have radiological evidence of pneumonia.[3]

This study was undertaken to provide detailed prospective epidemiology in order to understand these admissions better. It formed part of baseline data collection prior to the introduction of conjugate pneumococcal vaccination (PCV7) to allow evaluation

of its effect on LRI admission rates amongst a group at highest risk of pneumococcal disease.

Methods

Study population—Counties Manukau District Health Board (CMDHB) is responsible for approximately 433,000 people of whom 112,500 are 0–14 years of age including 30% European, 26% Pacific, 23% Māori, 15% Asian and 5% other or not stated.[5] The CMDHB Middlemore Hospital includes Kidz First Children's Hospital which provides secondary acute emergency and inpatient care for children aged 0–14 years from the CMDHB geographic area.

Ninety-five percent of children resident in the CMDHB area who are admitted with LRI are admitted to Kidz First. Children aged less than 2 years admitted to Kidz First with a primary diagnosis of LRI from 1 August 2007 to 23 December 2007 were eligible.

Those admitted with a clinical diagnosis of a lower respiratory infection (bronchiolitis, pneumonia, bronchopneumonia, bronchitis, empyema/lung abscess/TB/pertussis/pneumonitis) (ICD 10 bronchiolitis, ICD 9466.1, ICD 1010 J 21, pneumonia ICD 948486, 487, ICD 10 J 12–18, J 100 and J110, acute and specified lower respiratory infection ICD 10 J 22, acute bronchitis ICD 9 466, ICD 10 J20, lung abscess and parathorax ICD 9 510, 513, ICD 10 J 85–86, pertussis ICD 9 033, ICD 10 A37) were included.

Study procedures—Eligible patients were identified as part of daily screening of admissions by the study nurse and consent was obtained from parents for study participation. Detailed information on household characteristics was sought in a face to face parent questionnaire which included information on family, maternal age, housing, heating, smoke exposure and number in the house. Number of rooms in the house excluded bathrooms, showers, toilets, laundries, halls, garages and pantries.

Socioeconomic deprivation for each child was estimated using the NZDep2006[6]index for area of their residential address. The NZDep2006 index combines 9 variables from the 2006 NZ Census. Individual area scores are then ranked and placed on an ordinal scale from 1 to 10, with decile 10 representing the most deprived 10% of small areas. Children were clinically reviewed daily by the study nurse and the severity of illness documented. Nasopharyngeal aspirates were performed for viral and bacterial testing (data not presented in this paper.[7])

Relative risk of subgroups for at least one admission was calculated using the CMDHB 2007 birth cohort (data from National Minimum Dataset) as the denominator. In those admitted to hospital with LRI an analysis of risk factors related to total length of hospital stay in the 5 months of the study was performed.

A general linear model was fitted with the log of the total length of stay (the sum of all admissions) for a child as the outcome and child's age (at start of study), mothers age, ethnicity of child, deprivation index of home address (coded as 1-8 or 9,10) whether or not premature (<36 weeks), household density (number of rooms in house divided by the number of people in the house), number of smokers in the home and whether or not there was a source of heating in the house included as explanatory variables.

Analyses were also run with these variables included individually to ensure associations were not being obscured because of correlation among these explanatory variables. The study was approved by the Northern Regional Ethics Committee (NTX/07/07/059).

Results

During the study period there were 465 children with 580 admissions to Kidz First wards with LRI**.** Of these, 394 children (85%) with 508 admissions consented to the study. These admissions were similar to the total group in ethnicity and diagnosis.

Table 1. Characteristics of study children admitted to CMDHB facilities with LRI, 1 August 2007–23 December 2007

Variables	Cohort N=394	%	CMDHB births 2007 n=8833	%
Ethnicity				
Māori	118	29.9	1962	22.2
Pacific	221	56.1	2808	31.8
Other	55	14.0	4063	46.0
Deprivation				
1 (least) to 8	84	21.3	3990	45.2
9	124	31.4	1747	19.8
10 (most deprivation)	186	47.2	3066	34.7
Prematurity				
Less than 33/40	25	6.3	107	1.2
33/40 to 35+6	33	8.4	276	3.1
36/40 or more	336	85.3	8309	94.1

Table 1 compares the characteristics of the study population with that of the 2007 birth cohort. Relative risk for admission was 4.4 (95%CI 3.2–6.2) for Māori, 5.8 (95%CI 4.4–7.9) for Pacific peoples compared with others, and 3.1 (2.4–3.9) for those living in the most deprived quintile (NZ Dep 9 and 10) compared with those in NZ Dep 1–8 areas. Relative risk of admission was 5.8 (3.8–8.7) for those born at less than 33 weeks gestation and 3.0 (2.1–4.3) for those born at 33<36 weeks gestation compared with those born after 36 weeks.

Of the 508 admissions, 323 (64%) had a clinical diagnosis of bronchiolitis, 132 (26%) pneumonia, and 53 (10%) other LRI. Seventy-one (18%) had more than one admission and number of admissions ranged from 1 to 6. Length of stay ranged from 1 to 27 days with a median of 3 days. There was a total of 121 ICU bed days in 21 (5%) patients.

The characteristics of households are detailed in Table 2. It is of note that two-thirds of children were exposed to smoke in their home and that two-thirds of families had English as their first language with most others speaking Pacific languages (Table 2).

The median number of people in the house was 6, with range 2–31. Median number of adults was 2, median number of children 0–14y was 3, and 100 children (25%) lived in households with ≥7 other people. Thirty-three percent lived in households with four or more children. 224 (57%) had some period of full breastfeeding, 86 (22%) were partially breastfed. Twenty-seven percent lived in houses where caregivers reported never using any form of heating (Table 3).

Thirty-nine percent of Pacific families compared with 11% of Māori and 11% of other families had no source of heating.

Table 2. Characteristics of households of study children admitted with LRI to CMDHB, 1 August 2007–23 December 2007

Maternal age	N	%
<20 yrs	60	15.2
20–24 yrs	117	29.7
>25 yrs	217	55.1
Birth order		
1st child	125	31.7
4th or subsequent	98	24.9
First language		
English	266	67.5
Pacific	113	28.7
Asian	8	2
Māori	5	1.2
Child in house in daycare	111	28
No one in house in employment	44	11
Access to car during day		
Yes	336	85.3
No	58	14.7
Access to phone		
Yes	380	96.4
No	14	3.6
Smoking exposure		
Yes	257	65.2
No	137	34.8

Table 3. Heating source for households with study children aged <2 years admitted with LRI to Kidz First Children's Hospital, 1 August 2007–23 December 2007

Heating source	N	%
None	106	26.9
Electric	210	53.3
Bottled gas	68	17.3
Wood	54	13.7
Mains gas	10	2.5
Coal	5	1.3
Solar	1	0.3
Other	3	0.8

Therapy given during the admission is illustrated in Table 4.

Table 4. Therapies received by study children <2 years admitted with LRI to Kidz First Children's Hospital 1 August 2007 to 23 December 2007 by admission

Therapies	N	%
Respiratory		
Oxygen	361	71.0
CPAP	24	4.7
Ventilation	2	0.0
Fluids		
NG fluids	234	46.1
IV fluids	118	23.2
Medications		
Ventolin	140	23.2
Adrenaline	34	6.7
Atrovent	14	2.7

Reflecting severity, 5% of admissions received CPAP and 87% (n=441) received oxygen, salbutamol or supplementary fluids. In 57% (288) of the admissions supplementary fluid was given either via NG tube (46%) and/or as intravenous fluids (23%). In 224 admissions a full blood count was performed, 56 (25%) had an abnormal haemoglobin.

A primary care doctor was visited prior to 397 (78%) admissions. Following 390 (77%) admissions some form of follow-up was recommended after discharge, with 271 (53%) referred to the short-term Kidz First home nurse visiting service.

In those admitted to hospital the total days in hospital during the study period was associated with prematurity (p=0.005), ethnicity (p=0.02) and age of child (p=0.0002) with those who were premature, or Māori or Pacific ethnicity likely to have a stay approximately 40% longer than respectively those not premature or of European ethnicity.

The model also predicted every increase of a month in the child's age to result in a 3% reduction in length of stay (see Table 5). The estimates of the effect sizes differed only marginally when the explanatory variables were analysed individually, with no change in the variables able to be shown to be associated with length of stay.

Table 5: Regression coefficient estimates for the log of total length of stay (the sum of all admissions) for a child as the outcome and child's age in days (at start of study), mothers age in years, ethnicity of child, deprivation index of home address (coded as 1–8 or 9,10) whether or not premature (<36 weeks), household density (number of rooms in house divided by the number of people in the house), number of smokers in the home and whether or not there was a source of heating in the house included as explanatory variables..

Source		Estimate	SE*	p value
Ethnicity	Māori v Pacific	-0.01	0.10	0.02
	European/other v Pacific	-0.36	0.13	
Deprivation index	1–8 v 9,10	0.12	0.10	0.25
Premature	≥36 v <36wks	-0.34	0.12	0.005
Age child		-0.001	0.0003	0.0002
Age mother		-0.005	0.033	0.87
Household density		-0.004	0.050	0.93
Number smokers		0.01	0.03	0.67
Heating	Some vs none	-0.15	0.10	0.13

*SE: Standard Error.

Discussion

This study sought to provide more detailed epidemiology of admissions of CMDHB children aged less than 2 years with LRI. We have confirmed that in the CMDHB geographical area Māori and Pacific children, children resident in deprived areas and preterm infants are at high risk of admission for LRI. Most of these admissions are relatively short, but 20% had multiple admissions (up to 6) over this 5-month period.

We have shown that, of those admitted, younger infants, Māori and Pacific and premature children have a significantly higher number of days in hospital with LRI. Previous studies in Auckland have shown high rates of admissions for pneumonia in young Pacific children[8] and that Māori and Pacific children have more severe disease on admission. In both the UK and New Zealand admission rates for LRI are higher for children resident in areas of deprivation.[4, 9]

Two-thirds of the children were reported as smoke exposed at home. In the 2006 Census 40% of the South Auckland population aged 0–14 years were smoke exposed at home- a higher proportion than the national average.[10]

Many admitted infants have young mothers and live in large households, both previously identified risk factors for LRI [11] however, within those admitted to hospital, we did not find a significant association between hospitalised bed days and crowding as measured by people per room.

In a case control study of Auckland preschool children Grant el al showed an increased risk of acquiring pneumonia where there was household crowding and dampness, and an increased risk of hospitalization with these factors and with exposure to cigarette smoke in the home.[12]

Amongst indigenous populations such as Alaska Alaskan Native children living in households with 4 or more children aged <12 years had an increased risk of

hospitalisation with RSV.[13] One-third of our cohort lived in houses with 4 or more children under 15.

Surprisingly for a temperate climate and an area with poor housing insulation, just over a quarter report not using any heating in the winter, predominantly Pacific families. In comparison in the 2006 Census 1.4% of households in South Auckland stated that no fuels were used for heating.[14]

This study has identified a number of key areas for intervention. Cigarette smoke exposure *in utero* and postnatally is well recognised as increasing the risk of admission for LRI [15, 16]. There is a need to improve the identification of smoke exposed children both in utero and in the home and to offer support for smoking cessation.

Breastfeeding is also known to reduce the risk of admission for LRI [13, 17]. Promotion and protection of breastfeeding needs addressing to improve both initiation and exclusivity of breastfeeding.

Many of the children admitted live in large households with inadequate heating in low decile areas. Given the nature of our study without community controls we were unable to investigate the risk of household crowding on admission although crowding has been found to be associated with the risk of meningococcal disease[18].

There are three pieces of New Zealand research which suggest that housing and heating interventions may reduce admissions. In a community based single blinded cluster randomised study Howden-Chapman *et al* showed that insulation resulted in a small increase in bedroom temperatures in the winter despite lower energy consumption. They also found a substantial but non significant reduction (OR 0.53, CI 0.59-1.37) in the need for hospitalisation for respiratory illness[19]. In a further community based randomised study, they showed that installation of non polluting more effective home heating reduced symptoms of asthma, days off school, healthcare utilisation and visits to a pharmacist in school aged children with asthma.[20]

In 2011 Jackson reported on a pre/post intervention study of the Auckland based Healthy Housing programme which is a joint initiative between Housing New Zealand (social housing provider) and the local District Health Board. The programme concentrated delivery to defined geographic areas and sites for the programme were selected using the following criteria: a) "potentially avoidable hospitalisations", b) concentration of Housing New Zealand homes c) social deprivation rates and d) census reported overcrowding.

The primary focus was on the health of the children. A joint assessment of health and housing need was made with linkages made to other health and social services. Housing needs including crowding and insulation were addressed.

The results show a reduction in acute admissions in those under age 34 with the greatest reduction in the 5–34 year age group[21]. The programme so far has targeted small areas of high risk social housing, and does not include properties rented on the private market.

Admissions for infectious diseases are increasing nationally, and increasing inequalities by ethnicity and socioeconomic status have recently been shown by Baker et al.[22]

The risk factors for respiratory disease are also risk factors for a number of other health conditions prevalent in South Auckland including acute rheumatic fever, admissions to hospital with cellulitis and meningococcal disease[4]. The Māori and Pacific child and adult population in South Auckland also has very high rates of bronchiectasis which is being increasingly linked to LRI hospital admission in infancy.[23, 24]

We believe that for South Auckland the way forward, in addition to continuing to pursue full immunisation coverage including pneumococcal, is to progress with breastfeeding and smoking interventions given the known risk of these factors for LRI and their high rates in this hospital sample. Secondly to expand housing and social policy initiatives such as the proven healthy housing programme, despite the high up front costs and significant interagency cooperation and prioritisation of funding required.

Competing interests: Nil.

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