Household Transmission of *Streptococcus pneumoniae*, Alberta, Canada

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Proven or presumptive multidrug-resistant *Streptococcus pneumoniae* pneumonia was diagnosed simultaneously in three married couples in Alberta, Canada. The pair of isolates from each couple had identical antibiotic resistance profiles, serotypes, and pulsed-field gel electrophoresis patterns. One or more of these cases could have been prevented by *S. pneumoniae* vaccine.

Outbreaks of *Streptococcus pneumoniae* (antibiotic resistant and nonresistant) have been reported from child-care centers, nursing homes, hospitals, military camps, homeless shelters, and penal institutions (1-6). Simultaneous cases within households have rarely been reported (7-11); such cases require common exposure and transmission, as well as similar likelihood of disease in the hosts or increased virulence in the pathogen.

In December 1996 and January 1997, three married couples with multidrug-resistant *S. pneumoniae* (MDRSP) were admitted to Foothills Medical Centre in Calgary. The couples were not admitted on the same day. None of the couples lived with children, although couple C had daily contact with children. All patients received appropriate antibiotic therapy after their culture and antibiotic sensitivity results were known. We reviewed each patient's health record (Table) and were able to contact two of the three couples for further information.

S. pneumoniae were identified by standard methods. MICs were determined by E-Test (AB Biodisk, Solna, Sweden) and classified as susceptible (S), intermediate resistant (I), or fully resistant (R) to each antibiotic, according to National Committee for Clinical Laboratory Standards guidelines (12). Serotyping of *S. pneumoniae* was performed by the Quellung reaction technique at the National Centre for Streptococcus, Edmonton. Electrophoretic fingerprinting of *S. pneumoniae* was performed by pulsed-field gel electrophoresis (PFGE) of DNA digested with *Sma*1 (BRL, Gaithersburg, MD). The PFGE patterns were classified as indistinguishable, related, or different according to criteria suggested by Tenover (13).

The diagnosis of *S. pneumoniae* pneumonia in couple A was confirmed by positive blood cultures, chest X-ray lobar pneumonia, and disease-compatible clinical findings. Patient 1 in couple A was a health records clerk at Foothills Medical Centre. Her illness was complicated soon after admission by empyema, which was drained; the fluid was *S. pneumoniae*-negative. Vertebral osteomyelitis was suspected from clinical evidence 18 days after admission and was confirmed by bone scan; no diagnostic culture was obtained. Osteomyelitis in this patient was presumably caused by *S. pneumoniae*. The initial 7-day course of cefuroxime (to which *S. pneumoniae* was resistant) may not have cleared the infection and thus allowed secondary seeding to bone.

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Table. Clinical and laboratory features of three couples with *Streptococcus pneumoniae* pneumonia

	Couple A		Couple B		Couple C	
Feature	Patient 1	Patient 2	Patient 1	Patient 2	Patient 1	Patient 2
Age (yrs)	62	61	72	71	39	37
Chronic conditions	Hypertension, diabetes	Gout, 3 previous MIs[a]	Hypertension, CAD[b]	COPD[c]	Recurrent sinusitis	Recurrent sinusitis
Smoker	No	No	Yes	Yes	Yes	Yes
S. pneumoniae vaccine	No	No	Unknown	Unknown	No	No
Recent antibiotics	None	None	Unknown	Unknown	>3 courses in previous year	>3 courses in previous year
Others in home	None	None	None	None	None	None
Initial complaints	URTI[d] symptoms, cough, fever	URTI[d] symptoms, cough, fever	URTI[d] symptoms, cough, fever, chest pain	URTI[d] symptoms, cough, fever, chest pain, eye discharge	Burn, recent URTI[d] symptoms, cough, fever	Burn, recent URTI[d] symptoms, cough, fever
Physical exam	Febrile, ↑HR[e], ↑RR[f], severe distress, ↓breath sounds	Febrile, ↑HR[e], ↑RR[f], ↓breath sounds	Febrile, ↑HR[e], ↑RR[f], ↓breath sounds, ↓O_2 saturation	Febrile, ↑HR[e], ↑RR[f], ↓breath sounds	Febrile, ↑distress on ventilator, ↓breath sounds, crepitations	Febrile, ↑distress on ventilator, ↓breath sounds, crepitations
Chest X-ray (admission or as noted)	Right upper lobe consolidation	Right lower lobe consolidation	Bibasilar consolidation	Extensive right-sided consolidation	Day 3 – extensive bilateral consolidation	Day 2 – extensive bilateral consolidation
Admitting diagnosis	Right lobe pneumonia	Bilateral pneumonia	Pneumonia	Lobar pneumonia	Burn	Burn
Discharge diagnosis	Right upper lobe pneumonia	Right lower lobe pneumonia	Pneumonia	Lobar pneumonia	Burn, complicated by pneumonia	Burn, complicated by pneumonia fatal sepsis
Complications	Empyema, osteomyelitis	None	None	None	None	Died
Source of isolate	Day 1 - blood	Day 1 - blood	Day 1 - sputum (4+[i])	Day 1 - sputum (3+[i])	Day 3 - ETT[g] (4+[i])	Day 2 - BAL[h] (10^5 CFU/mL[i])
Gram stain	Not applicable	Not applicable	GPC resembling *S. pneumoniae*[j]	GPC resembling *S. pneumoniae*[j], GNB[k]	GPC resembling *S. pneumoniae*[j]	GPC resembling *S. pneumoniae*[j]
Other potential pathogens when pneumonia diagnosed	None	None	None	*H. influenzae* (3+[i])	GNB[k]	*H. influenzae* (10^3 CFU/mL[i])
Antibiotic susceptibility[l]						
Penicillin	2 R	1.5 I	1.5 R	2 I	1.5 I	1 I
Cefuroxime	4 R	6 R	3 R	4 R	6 R	4 R
Ceftriaxone	1 I	0.5 S	0.75 S	0.38 S	0.75 S	0.75 S
TMP/SMX[m]	≥32 R	≥32 R	≥32 R	≥32 R	≥32 R	≥32 R
Erythromycin	0.25 S	0.25 S	16 R	16 R	0.25 S	0.25 S
Serotype	14	14	9V	9V	9V	9V
PFGE pattern[n]	AA	AA	BB	BB	BC	BC

[a]Myocardial infarction.
[b]Coronary artery disease.
[c]Chronic obstructive pulmonary disease.
[d]Upper respiratory tract infection.
[e]Heart rate.
[f]Respiratory rate.
[g]Endotracheal tube.
[h]Bronchoalveolar lavage.
[i]For sputum or ETT aspirates, 3+ & 4+ reflect growth on the third and fourth set of streaks, respectively, on the culture plate; for BAL, sample fluid is an approximately 100-fold dilution of lung fluid.
[j]Gram-positive lancet-shaped cocci found singly, in pairs or in short chains.
[k]Gram-negative coccobacilli.
[l]Antibiotic susceptibilities reported as MIC (micrograms/mL) and as S (susceptible), I (intermediate) or R (resistant) (NCCLS criteria).
[m]TMP/SMX (trimethoprim/sulfamethoxazole).
[n]Pulsed-field gel electrophoresis.

Couple B (who could not be reached for further information) had had recent visitors from Texas (one a hospital worker) with upper respiratory tract infections. *S. pneumoniae* pneumonia was presumptively diagnosed in this couple on the basis of symptoms, signs, and chest X-rays compatible with the diagnosis of pneumonia, as well as sputum samples, which had gram-positive lancet-shaped cocci identified on Gram stain and grew *S. pneumoniae*. From the sputum of patient 2 in couple B, gram-negative bacilli were identified on Gram stain; *Haemophilus influenzae* was also isolated. Thus, this patient may have been coinfected, or primarily infected, with *H. influenzae*. The patient's blood cultures were negative; a blood culture was not performed on patient 1 in couple B.

Couple C was admitted with severe burns and inhalation injuries after the stove in their two-room trailer exploded. They had had recurrent sinusitis and other respiratory infections in the previous year since moving to their trailer, which had poor air circulation. Patient 1 of this couple was taking antibiotics at the time of admission, and patient 2 had recently completed a course of antibiotics. The diagnosis of pneumonia (patient 1 on day 3 of admission and patient 2 on day 2) was made on the basis of recent upper respiratory symptoms and fever, diminished breath sounds, crepitations, and disease-compatible chest X-ray findings (previous films had been normal), which made pneumonia more likely than noninfectious conditions such as acute lung syndrome. The presumptive diagnosis of *S. pneumoniae* as the etiologic agent in the case of patient 1, couple C, was made on the basis of the initial endotracheal tube aspirate, which had gram-positive lancet-shaped cocci identified on Gram stain and grew *S. pneumoniae*. Only gram-positive lancet-shaped cocci were identified from the initial bronchoalveolar lavage of patient 2 on Gram stain, and *S. pneumoniae* grew in much greater numbers than *H. influenzae*. Blood cultures, performed for couple C only after antibiotic therapy was started, were negative. Patient 2 died of septic shock 20 days after admission, with *Candida albicans* in his blood. The bronchopneumonia never resolved clinically, although *S. pneumoniae* was not isolated from any further cultures. Thus, *S. pneumoniae* may have been a contributing factor to, but not likely the direct cause, of this patient's death.

The identical susceptibility patterns, serotypes, and PFGE patterns indicate that both partners in each couple were infected with the same multidrug-resistant *S. pneumoniae* strain. Couples A and B apparently had community-acquired pneumonia. Although couple C contracted pneumonia 48 to 72 hours after admission, each partner entered the hospital already infected with MDRSP; the infecting organisms were identical, and no other recognized cases of nosocomial MDRSP occurred at Foothills Medical Centre at the time of their admission (they were admitted 1 month before couple B, who were also infected with serotype 9V MDRSP). Couple A may have been exposed to MDRSP as a result of one partner's work in a tertiary-care hospital; couple B as a result of one partner's exposure to a health-care worker with respiratory symptoms. At the time of these cases, the prevalence of penicillin-nonsusceptible *S. pneumoniae* infections in Calgary was approximately 10% (A.P. Gibb, unpub. data).

None of these patients had received *S. pneumoniae* vaccine, yet each had one or more risk factors for infection (advanced age, exposure to young children, smoking, and chronic lung or heart disease). Couple C had a history of recent antibiotic use, the predominant risk factor for antibiotic-resistant infections.

In Canada, the *S. pneumoniae* vaccine is recommended for all persons ≥65 years old and persons ≥2 years with identified risk factors (14). Despite the vaccine's reasonable effectiveness, its use has been very low in Canada until recently (fewer than 12 doses per 10,000 population distributed annually [15,16]). The vaccine has been provided free of charge to persons with medical indications, but not to healthy persons 65 years of age and older and not as part of a routine vaccination schedule (17). Some provinces (including Alberta, beginning in 1998) have begun to routinely provide the vaccine to all persons at risk. The current incidence of invasive *S. pneumoniae* infections in Calgary is 20 per 100,000 per year overall and 87 per 100,000 per year in those older than 64 years of age (J.D. Klein, unpub. data).

Outbreaks of *S. pneumoniae* disease occur in institutions with crowding, poor air quality, or increased host susceptibility (2,4,6). These factors may also exist within households (9,11). Couple C, for example, lived in a very crowded space with poor air circulation.

The rate at which secondary *S. pneumoniae* infections occur in household contacts of index patients with invasive disease is not known, but rare cases have been reported (7-11). Factors contributing to secondary infections include the likelihood of nasopharyngeal infection due to exposure to the index patient or a common source, susceptibility to the strain of the index infection, and likelihood that colonization will lead to disease rather than to development of asymptomatic immunity. Data on contemporaneous nasopharyngeal carriage of the outbreak strain by household contacts are limited. A recent study from Gambia found carriage in 8.5% of household contacts, compared with 21% in an older U.S. study (18,19). In healthy adults, the prevalence of circulating *S. pneumoniae* antibodies is low (4% to 34%, depending on the serotype); however, two thirds of adults have protective antibody within 1 month of colonization (20). Approximately 15% of children who acquire a new *S. pneumoniae* strain nasopharyngeally in a nonoutbreak setting acquire clinical disease (usually otitis media); this rate is unknown for adults (21). In contrast, during a recent nursing-home pneumonia outbreak, 23% of residents were infected with the *S. pneumoniae* outbreak strain, and 4% became ill (22). The median age of residents was 85 years; only 4% had received *S. pneumoniae* vaccine.

Increased use of *S. pneumoniae* vaccine may prevent MDRSP pneumonia within households and among persons living in crowded conditions.

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