Detection of Chlamydiosis in a Shipment of Pet Birds, Leading to Recognition of an Outbreak of Clinically Mild Psittacosis in Humans

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Psittacosis is a zoonotic illness caused by *Chlamydia psittaci* and is typically transmitted through inhalation of aerosolized bird excreta. The illness may include fever, chills, headache, myalgia, and malaise, with or without respiratory symptoms, and can vary greatly in its severity. Psittacosis was first recognized in the United States in 1904. Except for a pandemic linked to a large shipment of infected parrots exported from Argentina, which led to >700 cases of psittacosis worldwide from 1929 to 1930 [1], outbreaks have been small and uncommon. Sporadic cases have usually been linked to companion bird exposures [2], and most recently, published investigations of psittacosis outbreaks have identified occupational exposure to turkeys and ducks [3–6] and domiciliary exposure to psittacine birds [7, 8] as sources of infection. These outbreaks were initially recognized after human psittacosis was diagnosed and were followed by an active search for avian chlamydiosis to identify the source of the outbreak. We describe an outbreak in which recognition of avian infection led to an active search for cases of psittacosis in humans.

In August 1995, >700 birds were shipped from a Florida bird distributor to nine Atlanta-area pet stores that are part of a national chain. Three weeks later, the Georgia Department of Agriculture (GDA) was notified that a bird purchased from the pet store chain had died of chlamydiosis shortly after purchase. Chlamydiosis was diagnosed at necropsy by using the tissue staining methods of Gimenez and Macchiavello [1], according to guidelines established by the National Association of State Public Health Veterinarians [9]. Georgia’s Bird Dealer Licensing Act [10] requires pet bird retailers to keep records identifying both the supplier and the purchaser of birds and to report cases of chlamydiosis to the GDA. Store records showed that the dead bird was part of the August shipment, that many other birds from this shipment were dying in the stores, and that dead birds were being returned to the stores by unhappy customers. GDA officials issued a press release directing bird purchasers with symptoms to contact the Georgia Department of Human Resources (GDHR), which soon afterwards began to receive reports of illness among persons who had recently purchased birds. All the birds from the Florida distributor were supplied by a breeder in Oklahoma.

Methods

Bird purchasers reporting illness to the GDHR were interviewed by telephone to characterize the reported illnesses. Investigators visited households of persons reporting a symptom complex suggesting psittacosis (respiratory symptoms and fever) and offered diagnostic testing for psittacosis. For the purposes of this investigation, psittacosis was defined as an illness consisting of fever or chills plus one or more of the following symptoms: cough, shortness of breath, chest pain, headache, or myalgia. The diagnosis of psittacosis was serologically confirmed if the titer of IgG to *C. psittaci*, measured by microimmunofluorescence, was ≥1:32 or if the titer of IgM to *C. psittaci* was ≥1:16 and the titers of IgM and IgG, measured by microimmunofluorescence, to *Chlamydia pneumoniae* were no higher than those to *C. psittaci* [11]. Because this outbreak...
occurred during the summer, when the incidence of respiratory infections is typically lowest [12], testing for respiratory pathogens other than *Chlamydia* species was not done.

After reviewing the records of bird sales during August that were obtained by GDA officials, we telephoned households with birds purchased from the implicated stores during August 1995 and administered a standardized questionnaire to identify possible additional cases. At least three attempts, each during a different time of day, were made to reach each household by telephone. An adult from each household was interviewed regarding underlying medical conditions and the development of illness in each household member, the health status of the newly purchased bird, and exposures of each household member to the bird. All members of the household were offered free serological testing (microimmunofluorescence) through the local health department.

To establish the baseline rate of respiratory illness in the community during the outbreak, the adult respondents from each household with a recently purchased bird (exposed households) were asked to identify an unexposed household in the Atlanta area whose members had not visited the exposed household since purchase of the bird. An adult member of each unexposed household was contacted by telephone, and a standardized questionnaire was administered after it had been confirmed that the household had not been exposed to a bird from the implicated flock. The questionnaire administered to respondents from unexposed households differed from the one administered to respondents from exposed households only in that questions about the newly purchased bird were omitted. Members of unexposed households were not offered serological testing.

Birds in the exposed households were tested for chlamydiosis by culture [13] and multiplex PCR assay [14] of fresh droppings collected during the household visits. Representatives from the GDA collected dead birds from the Atlanta outlets of the pet store chain. These birds had either died in the stores or had been returned by customers. The birds were tested for chlamydiosis by using the methods of Gimenez and Macchia
tello, and a subset of these dead birds was also tested at the Centers for Disease Control and Prevention (CDC) by culture and PCR assay of liver and spleen homogenate. Antigen from *C. psittaci* cultured from avian specimens was added to the antigen suspension used for microimmunofluorescence testing of human serum.

Data entry and statistical analysis were done with Epi-Info software (version 6.01, CDC/World Health Organization, Atlanta) and SAS software (version 6.12, SAS Institute, Cary, NC). Odds ratios and risk ratios were calculated by using unconditional maximum likelihood methods [15, 16]. Generalized estimating equation techniques were used to account for the clustered nature of the data—i.e., where responses from family members and residents within a household were inherently correlated. In all instances where odds ratios and risk ratios are expressed, these values describe associations for persons and not for the clustered units (i.e., the households). The confidence intervals and *P* values incorporate the within-household variability because of this clustered study design.

**Results**

Records of 225 bird sales transactions were recovered from the nine chain pet stores in Atlanta during August 1995. Parakeets (*n* = 166 households), finches (*n* = 23), cockatiels (*n* = 14), lovebirds (*n* = 8), conures (*n* = 2), canaries (*n* = 2), and parrots (*n* = 2) were the most commonly purchased birds. Because some households purchased more than one bird during the interval, 215 households were identified as having birds that were purchased from the chain in August. The members of four households refused to participate in the survey, and 97 households could not be contacted because store records were illegible or incomplete or there was no answer after three attempts. A total of 114 exposed households (53%) were successfully contacted and completed the questionnaire between 8 September and 11 October 1995. Representatives from 10 of these households had contacted the GDHR in response to the press release before they completed the questionnaire.

Of 428 persons in the exposed households, 46 (attack rate [AR] = 10.7%) from 29 of the households had illnesses that met the clinical case definition for psittacosis, compared with 1.8% of 167 persons from 48 unexposed households (OR = 6.60; 95% CI = 1.39–31.2). Individuals from exposed and unexposed households did not differ significantly with respect to age, gender, existence of underlying medical conditions, or the frequency with which medical attention was sought for respiratory illnesses. Symptomatic exposed household members reported onsets of illness between 10 August and 29 September, with 61% of cases occurring during the 3-week interval that began 19 August. An average of 21 days (range, 1–47 days) elapsed between the purchase of a bird and the onset of symptoms. Sixteen (34.8%) of the persons with clinical psittacosis were from households that contacted the GDHR in response to the press release.

Among persons in exposed households, illness was more common if the recently purchased bird had become sick or had died (number of persons exposed, 90; RR = 2.97; 95% CI = 1.45–6.11). Illness was slightly more common in households where the bird had been let out of the cage to move about the house (number of persons exposed, 204; RR = 1.85; 95% CI = 0.80–4.29). Kissing or nuzzling the bird, handling the bird, and feeding the bird were all significantly associated with the development of clinical psittacosis, but cleaning the bird’s cage was not (table 1).

Eighteen persons (39%) who became ill reported seeking medical attention; chest radiographs were obtained for four of these persons, and two had radiographic evidence of pneumonia. Twelve of these persons were given a prescription for an antibiotic, but only 75% received an antibiotic with activity against *C. psittaci* (either a macrolide, a quinolone, or tetry-
Table 1. Activities related to the risk of developing clinical psittacosis and of clinical or serological evidence of psittacosis.

<table>
<thead>
<tr>
<th>Bird exposure</th>
<th>Clinical psittacosis</th>
<th>No illness</th>
<th>RR</th>
<th>95% CI</th>
<th>Clinical psittacosis or seropositivity</th>
<th>No illness or seropositivity</th>
<th>RR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kissing</td>
<td>16 (52)</td>
<td>44 (28)</td>
<td>2.33</td>
<td>1.07–5.08</td>
<td>17 (47)</td>
<td>43 (28)</td>
<td>1.95</td>
<td>0.97–3.93</td>
</tr>
<tr>
<td>Handling</td>
<td>28 (61)</td>
<td>145 (39)</td>
<td>2.17</td>
<td>1.18–3.97</td>
<td>33 (61)</td>
<td>140 (38)</td>
<td>2.19</td>
<td>1.26–3.80</td>
</tr>
<tr>
<td>Feeding</td>
<td>29 (63)</td>
<td>173 (46)</td>
<td>1.83</td>
<td>1.01–3.34</td>
<td>35 (65)</td>
<td>167 (45)</td>
<td>1.98</td>
<td>1.14–3.44</td>
</tr>
<tr>
<td>Cage cleaning</td>
<td>20 (43)</td>
<td>151 (40)</td>
<td>1.11</td>
<td>0.64–1.91</td>
<td>24 (44)</td>
<td>147 (40)</td>
<td>1.16</td>
<td>0.69–1.94</td>
</tr>
</tbody>
</table>

NOTE. Responses for each exposure total less than the number of patients surveyed (n = 428) because household members completing the questionnaire for others in the household were given the option of responding ‘‘don’t know.’’

transmission of psittacosis was found in 35 (30.7%) of exposed households when the clinical and serological case definitions were combined.

The incidence of clinical illness varied significantly by type of bird to which persons were exposed. Most persons were exposed to parakeets (n = 322), and 9.6% of these persons became ill. The attack rate was significantly higher for persons exposed to parrots than for those exposed to parakeets (n = 6; AR = 66.7%; RR = 6.92; 95% CI = 3.59–13.36). The attack rates for persons exposed to conures (25.0%), lovebirds (17.4%), or finches (11.8%) did not differ significantly from those for persons exposed to parakeets. No one exposed to canaries or cockatiels reported symptoms meeting the case definition. All serologically confirmed cases of psittacosis occurred among persons who had contact with either lovebirds (n = 3) or parakeets (n = 7), and the results did not vary significantly by type of bird. No one exposed to a parrot agreed to serological testing.

Table 2. Symptoms compatible with psittacosis in 46 persons from households with exposure to pet birds with chlamydiosis.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Percentage of persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fever</td>
<td>96</td>
</tr>
<tr>
<td>Headache</td>
<td>76</td>
</tr>
<tr>
<td>Cough</td>
<td>69</td>
</tr>
<tr>
<td>Nasal symptoms</td>
<td>61</td>
</tr>
<tr>
<td>Myalgia</td>
<td>59</td>
</tr>
<tr>
<td>Sore throat</td>
<td>59</td>
</tr>
<tr>
<td>Gastrointestinal symptoms</td>
<td>55</td>
</tr>
<tr>
<td>Chills</td>
<td>50</td>
</tr>
<tr>
<td>Chest pain</td>
<td>16</td>
</tr>
<tr>
<td>Dyspnea</td>
<td>12</td>
</tr>
</tbody>
</table>

Discussion

The epidemiological and laboratory findings of this investigation suggest that C. psittaci was transmitted from infected pet birds to persons in 30.7% of households that purchased these birds. Persons who had greatest contact with the birds
were more likely to develop illness or serological evidence of psittacosis, even in the absence of illness.

The illnesses reported by persons who had recently purchased birds were mild, and serological testing suggested that many of these exposed persons had asymptomatic infection. In a previous investigation of psittacosis acquired at a turkey processing plant, few of the employees had evidence of asymptomatic chlamydia infection [4]. The differences in the findings of the two investigations could be due to the use of the newer microimmunofluorescence test vs. CF for serological diagnosis. It is also possible that in the present outbreak, household members who had contact with pet birds received lower inocula of organisms, resulting in milder illness or no illness and weaker antibody responses, than persons who processed the carcasses of infected birds. Factors associated with the severity of illness have not been fully delineated, but the degree of exposure may be a factor, as suggested by the case of a man who developed life-threatening psittacosis after administering “mouth to beak” resuscitation to his ill, newly purchased parrot [17].

The occurrence of asymptomatic infection with *C. psittaci* is not surprising, since the two other *Chlamydia* species pathogenic in humans, *Chlamydia trachomatis* and *C. pneumoniae*, frequently cause clinically silent infection [18]. The commonly reported symptoms of ill residents of households with recently purchased birds were consistent with those reported in case series [17, 19, 20]. Nonetheless, in other settings, *C. psittaci* infections acquired from pet birds can have severe, even fatal courses [21, 22]. The mildness of the illnesses observed in this outbreak may also have been due to low virulence of the infecting strain of *C. psittaci*. The two prevalent serovars of *C. psittaci* in the avian population of the United States have been found to infect particular hosts and to cause particular pathologies [23]. The *C. psittaci* strain in the present outbreak may be one that typically causes mild or asymptomatic illness in otherwise healthy humans.

Psittacosis is likely underdiagnosed and consequently underreported because of the challenges associated with confirming the diagnosis. This outbreak of human psittacosis was identified by recognition of avian chlamydiosis, followed by an active search for human cases. Infection in birds was detected because compliance with the Georgia Bird Dealer Licensing Act led to notification of the GDA when a chlamydiosis-related death was confirmed. Throughout the United States in 1995, 64 cases of psittacosis were reported to CDC through a passive surveillance system. Only five of those reported cases occurred in Georgia [24]. All cases of human psittacosis in this outbreak were first identified through active case-finding with use of store records or when members from exposed households contacted the GDHR after the GDA’s press release was issued.

The passive surveillance system for human disease did not contribute to our case-finding. While the use of an avian surveillance system like the one established by Georgia’s Bird Dealer Licensing Act may aid in the identification of cases of human psittacosis, many of which might never be reported because of their mild or asymptomatic course, it would be impractical to conduct outbreak investigations such as this one whenever a case of avian chlamydiosis is identified. In 1995, 295 birds were tested for chlamydiosis at the GDA laboratory, and 37 (12.5%) tested positive (P. O. Williams, personal communication). Only three of the birds that tested positive were associated with this outbreak.

Measurement of acute- and convalescent-phase antibody titers by using CF or microimmunofluorescence is recommended to confirm the diagnosis of psittacosis [9, 25], although microimmunofluorescence appears to be more sensitive and specific than CF for testing persons with clinical evidence of psittacosis [11]. The results of CF antibody tests cannot be used to distinguish respiratory illnesses caused by *C. psittaci* from those caused by *C. pneumoniae*, and the latter species is a much more common cause of community-acquired pneumonia [12]. In one outbreak of psittacosis identified by CF, reexamination of sera by microimmunofluorescence showed that the illnesses were actually caused by *C. pneumoniae* and not *C. psittaci* [26]. It is likely that the lower number of psittacosis cases reported in the United States during the 1990s than in the two earlier decades represents the recognition of and specific diagnostic testing for *C. pneumoniae* during recent years [24, 27]. In the present investigation, the utility of serological testing by microimmunofluorescence was limited because only single serum specimens, rather than paired specimens, were available for testing.

The sensitivity of serological testing may have been further reduced among persons with psittacosis who were treated with antibiotics active against *Chlamydia* species because therapy may blunt the antibody response to infection [28]. Thus, antibiotic therapy may also have contributed to the lack of correlation between clinical illness and serological evidence of infection. The sensitivity of microimmunofluorescence was not improved when sera were retested with *C. psittaci* antigen from avian specimens associated with this outbreak.

Culture of *Chlamydia* species is technically difficult and should only be attempted in laboratories with appropriate biocontainment facilities. Because of their superior speed, safety, and sensitivity, PCR and antigen detection tests will likely provide important means of diagnosing psittacosis in humans in the future [29, 30]. We found that PCR analysis of improperly handled avian specimens was better for detecting *C. psittaci* than were traditional tissue staining methods. For flocks with unusually high mortality rates of unknown cause, application of PCR or culture to pooled tissue specimens, even if they have been improperly handled, may save time and costs compared with other methods for diagnosing avian chlamydiosis.

To better detect and prevent psittacosis in humans, pet store personnel should be instructed in the recognition of avian illness and in the proper handling of dead birds so that detection of *C. psittaci* is more likely and appropriate control measures can be implemented [9]. Persons purchasing pet birds should be informed about the risk of psittacosis so that, should illness
develop, these persons will seek medical attention for appropriate diagnostic testing and treatment, particularly if their birds have become ill or have died. Wider use of PCR and microimmuno-fluorescence will improve diagnostic capabilities and increase recognition of both avian chlamydiosis and human psittacosis.

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References