

# Presenting Features of Feather Duvet Lung

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## Key Words

Extrinsic allergic alveolitis · Hypersensitivity pneumonitis · Bird fancier's lung · Feather duvet lung · Goose feathers · Duck feathers

## Abstract

**Background:** Feather duvet lung (FDL) is a rare subgroup of bird fancier's lung. It is caused by inhalation of organic dust due to goose or duck feathers in duvets or pillows. **Methods:** A retrospective review of the medical records of 13 patients with FDL was performed to assess the specific history and review clinical characteristics of patients with this disease. **Results:** All patients were female with a mean age of 53 years (26–71). They were recently exposed to feather duvets (6), pillows (1) or both (6). Specific histories were duvets or pillows filled with raw goose feathers from their own farms (4), intensive contact with goose feathers in youth (3), and bird exposure prior to symptom onset (5). In all patients specific IgG antibodies to goose and/or duck feathers were detected. Pulmonary function tests revealed a moderate to severe reduced diffusion capacity and a mild restrictive pattern. High-resolution computed tomography was performed in 11 patients and demonstrated predominantly ground-glass opacities (10) and fibrosis (6). In bronchoalveolar lavage fluid, lymphocytic alveolitis was demonstrated in all patients. Lung biopsies were obtained in 9 patients and demonstrat-

ed lymphocytic alveolitis (8), granulomas (3), bronchiolitis obliterans organizing pneumonia pattern (2), and usual interstitial pneumonia pattern (1). **Conclusions:** The clinical findings of FDL are typical of extrinsic allergic alveolitis. Primary sensitization could be due to former exposure to bird antigens at home or goose/duck feather exposure in youth. In view of the increasing popularity of feather duvets, FDL should be considered in the differential diagnosis of patients with extrinsic allergic alveolitis.

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## Introduction

Extrinsic allergic alveolitis (EAA), also known as hypersensitivity pneumonitis, represents an immunologically mediated diffuse interstitial and alveolar lung disease. It is caused by repeated inhalation of various antigens, such as organic dust particles or small-molecular-weight chemicals [1]. The clinical course of EAA is usually classified as 'acute', 'subacute' or 'chronic' disease, but the 'subacute' disease seems difficult to define [2]. There are various diagnostic criteria for EAA [3–6], but all of them of limited diagnostic accuracy [7]. Typically, diagnostic criteria for acute/subacute disease are exposure to a known offending antigen, recurrent episodes of symptoms (flu-like syndrome) occurring 4–8 h after

exposure, positive antigen-specific IgG antibodies, inspiratory crackles on physical examination, weight loss, diffuse micronodular pattern with air trapping and ground-glass attenuation on high-resolution computed tomography (HRCT), bronchoalveolar lavage (BAL) lymphocytosis and a histological pattern of granulomatous pneumonitis with areas of organizing pneumonia [8]. In chronic diseases the clinical and diagnostic features can be different [9, 10].

Probably the most common form of EAA is bird fancier's lung (BFL) caused by exposure to wild or domestic birds, such as pigeons, budgerigars, parrots or other small cage birds [8]. Antigen sources are bird excrement, feathers and serum [11]. Other rare and in some senses curious sources are feathers from stuffed birds [12] or dust from South American feathers used in artificial flies for the fishing industry [13]. Feather duvet lung (FDL) is a rare subgroup of BFL caused by feathers from duvets or pillows [14]. Strongly positive specific IgG antibodies against goose feathers are detectable [15]. In patients with chronic BFL acute exacerbation due to use of a feather duvet is possible [16]. The aim of the present study is to demonstrate the specific history and presenting features of patients with acute and chronic FDL. To the best of the authors' knowledge, this is the largest detailed case study of reported patients with FDL.

## Patients and Methods

### *Patients*

We retrospectively reviewed the medical records of all cases with a clinical diagnosis of FDL in the Fachkrankenhaus Coswig (n = 10) during the period of 2005–2008 and the Zusatzklinik of DRV Schwaben (n = 3) during the period of 1985–2005. The diagnostic criteria for EAA included (1) a definite history of using feather duvets and/or pillows, (2) recurrent episodes of symptoms compatible with EAA, (3) elevated/positive specific IgG antigens to goose or duck feathers, (4) inspiratory crackles on physical examination, (5) findings compatible with EAA on chest radiograph or HRCT scan, (6) decreased diffusing capacity and/or arterial hypoxemia, either at rest or during exercise, (7) lymphocytic alveolitis in BAL fluid, (8) pulmonary histological changes compatible with EAA, (9) a positive inhalative challenge, and (10) a positive avoidance test. The diagnosis was confirmed if the patient fulfilled 6 of the 10 criteria [6].

### *Clinical Investigations*

Antigen-specific IgG antibodies against goose or duck antigens were measured in all patients either with a quantitative solid-phase indirect fluorimetric enzyme immunoassay automated system used according to the manufacture's instructions [UniCAP 100, Sweden Diagnostics (UK) Ltd, Milton Keynes, UK] [17] or by using the qualitative double diffusion test according to Ouchter-

lony in agar gel with visible precipitin lines [18–20]. Pulmonary function tests and arterial blood gas analysis were performed in all patients in the initial phase of investigation. HRCT of the thorax was performed in all but 2 patients. BAL was performed in all patients for a differential cell count and to characterize the phenotype of the T cells recovered from the BAL fluid (anti-CD4 and anti-CD8). A lung biopsy was taken in 9 patients, a bronchoscopic transbronchial biopsy in 7, and an open lung biopsy in 2. Inhalation challenge tests were performed in 3 patients (No. 2, 11 and 12) after obtaining written informed consent. These 3 patients had doubts about the clinical diagnosis of FDL and wanted to confirm it by an inhalative challenge. The tests were performed in a clinical setting where the patients had to toss the feathers of their own pillow. The following parameters were documented at 2, 4, 6, 8, (12) and 24 h after an exposure of 1 h: symptoms and clinical status, pulmonary function tests, arterial blood gas analysis and hemogram. The challenge tests were interpreted according to the criteria of the German working group on EAA [21]. Patients who fulfilled at least two systemic and at least two pulmonary criteria were considered positive. Systemic reactions were (1) development of systemic symptoms including chills and general fatigue (flu-like illness), (2) increase in body temperature  $\geq 1.0^{\circ}\text{C}$ , and (3) increase in peripheral leukocyte count by  $>2,500/\text{mm}^3$ . Pulmonary reactions were (1) development of respiratory symptoms (dyspnea, cough or inspiratory crackles), (2) decrease of diffusing capacity for carbon monoxide (DLCO) by  $\geq 15\%$  and/or decrease of  $\text{PaO}_2$  by  $\geq 7\text{ mm Hg}$ , and (3) decrease of FVC and/or TLC by  $\geq 20\%$ .

## Results

The history of symptoms and the association with bird keeping are summarized in table 1. All of the 13 patients were female. The mean age at clinical presentation was 53 years (26–71). All patients complained about dyspnea, 7 only during exercise. Other clinical symptoms were dry cough (9), fever (3), night sweats (2) and weight loss (2). The duration of exposure to new feather duvets prior to symptom onset was highly variable, ranging from 3 weeks to more than 5 years.

All patients had recently been exposed to feather duvets (6), pillows (1) or both (6), filled with goose or duck feathers. In 4 patients the pillows and duvets were filled with goose feathers from their own goose farms, 3 patients had had intensive contact with goose feathers in their youth, and 2 reported dyspnea and fever after plucking goose feathers. In 8 cases the feather duvet was filled with goose feathers, in 1 with goose and duck feathers, in 1 only with duck feathers, and in 3 it was not known.

In 5 cases a history of bird keeping coexisted: in 4 cases 8–15 years prior to symptom onset and in 1 case 6 months prior to symptom onset. Only in 1 case were symptoms related to prior bird (parrot) exposure and a

**Table 1.** Patients' history of symptoms and association with bird keeping

| Case No./age years | Symptoms related to feather duvets or pillows                                                                                                                                                                                   | Period between current first exposure and symptom onset | History of bird keeping                                                              |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------|--------------------------------------------------------------------------------------|
| 1/27               | Dyspnea and dry cough; duvet and pillow from own goose farm                                                                                                                                                                     | 4 months                                                | Ø                                                                                    |
| 2/68               | Dyspnea and dry cough for the past year after sleeping with new duvets filled with goose feathers; after the diagnosis was made the patient accidentally slept again with a pillow resulting in fever and dyspnea               | 3 months                                                | Ø                                                                                    |
| 3/26               | Dyspnea, dry cough and fever after sleeping with new duvets filled with goose feathers; previously sleeping with old duvets for at least 5 years                                                                                | 3 weeks                                                 | Ø                                                                                    |
| 4/52               | Dyspnea on exercise, dry cough and weight loss of 5 kg for the past 2 years                                                                                                                                                     | 2 years                                                 | Budgerigar keeping for 3 years without any symptoms, 10 years before the new duvets  |
| 5/43               | Dyspnea and dry cough for the last 6 months, when duvets were changed to old ones filled with goose and duck feathers; previously sleeping with feather duvets for 11 years                                                     | 3 months                                                | Ø                                                                                    |
| 6/63               | Dyspnea on exercise and dry cough after sleeping with new duvets and pillows filled with goose feathers                                                                                                                         | 3 months                                                | Ø                                                                                    |
| 7/56               | Dyspnea on exercise for the past year; duvets filled with goose feathers from own goose farm; goose farming in the neighborhood with >2,000 geese                                                                               | At least 5 years                                        | Ø                                                                                    |
| 8/71               | Dyspnea on exercise and night sweats for the past 2 years; in their youth, dyspnea and fever after plucking goose feathers; sleeping with duvets filled with goose feathers from own farm                                       | At least 5 years                                        | Ø                                                                                    |
| 9/58               | Dyspnea on exercise, dry cough and night sweats for the past 3 months after sleeping with duvets and pillows filled with goose feathers from the parents' farm; in their youth, dyspnea and fever after plucking goose feathers | 3 months                                                | Budgerigar keeping for 10 years without any symptoms, 15 years before the new duvets |
| 10/55              | Dyspnea on exercise for the past year after sleeping with new duvets and pillows filled with goose feathers; no symptoms at a camping-site while sleeping without duvets; childhood on a goose farm                             | 2 months                                                | Ø                                                                                    |
| 11/49              | Dyspnea on exercise, dry cough, weight loss of 4 kg; new duvets filled with goose feathers 3 years ago                                                                                                                          | 2 years                                                 | Budgerigar keeping 10 years ago without symptoms                                     |
| 12/26              | Dyspnea, dry cough and fever after sleeping with a new duvet (goose feathers) and a new pillow (duck feathers); previously having slept with old duvets for years                                                               | 3 weeks                                                 | Budgerigar keeping 6 months ago without symptoms                                     |
| 13/64              | Dyspnea on exercise for the last 2 months after sleeping with a new pillow filled with duck feathers; 8 years ago diagnosis of a BFL due to a parrot                                                                            | 2 months                                                | Parrot keeping 8 years ago; stopped due to the diagnosis of BFL                      |

diagnosis of BFL was made. In this case the bird exposure was stopped 8 years before the new symptoms started as a result of a new feather duvet.

The clinical findings are summarized in table 2. In all 13 patients positive specific IgG antibodies were detected against either goose or duck feathers (11 positive for goose feathers, 12 positive for duck feathers). Pulmonary function testing was performed at the first presentation. In all patients a reduction of DLCO was found; in 8 patients it was below 50% of predicted ( $46.7 \pm 11.1\%$  of predicted, mean  $\pm$  SD). A mild restrictive pattern was found (FVC  $69.7 \pm 12.2\%$  of predicted, mean  $\pm$  SD), but no airflow obstruction was present (FEV<sub>1</sub>/FVC  $90.4 \pm 6.5\%$  of predicted, mean  $\pm$  SD).

HRCTs of the chest were available in 11 cases and chest radiographs in the remaining 2, all with abnormal findings. Diffuse ground-glass opacities were seen in the

HRCTs of 10 patients and in the 2 chest radiographs. The HRCTs also showed fibrosis in 6 patients and traction bronchiectasis in 3 patients.

Results of BAL showed a marked lymphocytosis of  $53 \pm 16\%$  (mean  $\pm$  SD) in all 13 patients with a median CD4:CD8 lymphocytic ratio of 0.6 (range 0.2–3.7).

Lung biopsies were performed in 9 patients (7 underwent transbronchial lung biopsy and 2 surgical biopsy). The histological findings revealed lymphocytic alveolitis in 8 patients, loosely organized nonnecrotizing granulomas in 3 patients, a bronchiolitis obliterans organizing pneumonia pattern in 2 patients and in 1 patient with surgical lung biopsy, an usual interstitial pneumonia (UIP) pattern.

The inhalative challenge with feathers from the patients' own duvets or pillows showed a significant systemic and pulmonary reaction in all 3 cases.

**Table 2.** Clinical findings in patients with FDL

| Case No. | Lung function, % |      |                       |      |      | Specific IgG antibodies | Radiology        | BAL lymphocytosis, %/<br>CD4/CD8 ratio | Pathology of lung biopsy |
|----------|------------------|------|-----------------------|------|------|-------------------------|------------------|----------------------------------------|--------------------------|
|          | FEV <sub>1</sub> | FVC  | FEV <sub>1</sub> /FVC | TLC  | DLCO |                         |                  |                                        |                          |
| 1        | 67               | 64   | 91                    | 75   | 24   | G+, D+                  | HRCT: GGO        | 55/0.7                                 | TBB: A, G, BOOP          |
| 2        | 65               | 76   | 73                    | 83   | 57   | G+, D+                  | HRCT: GGO, F, TB | 31/0.5                                 | SLB: A                   |
| 3        | 78               | 69   | 98                    | 87   | 51   | G+, D+                  | HRCT: GGO        | 35/1.4                                 | TBB: A, G, BOOP          |
| 4        | 88               | 81   | 98                    | 79   | 39   | G+, D+                  | HRCT: GGO        | 61/1.9                                 | TBB: A                   |
| 5        | 55               | 48   | 98                    | 61   | 59   | G+, D+                  | HRCT: GGO, F     | 76/0.3                                 | n.p.                     |
| 6        | 64               | 62   | 91                    | 80   | 33   | G+, D+                  | HRCT: GGO        | 60/0.4                                 | n.p.                     |
| 7        | 88               | 83   | 89                    | 82   | 43   | G+, D+                  | HRCT: GGO, F, TB | 30/0.3                                 | SLB: UIP                 |
| 8        | 86               | 80   | 85                    | 80   | 45   | G+, D+                  | HRCT: F, TB      | 69/3.7                                 | TBB: A                   |
| 9        | 69               | 70   | 90                    | 78   | 44   | G+, D+                  | HRCT: GGO        | 55/1.7                                 | TBB: A                   |
| 10       | 80               | 73   | 91                    | 71   | 47   | G+, D+                  | HRCT: GGO, F     | 72/0.5                                 | TBB: A                   |
| 11       | 119              | 64   | 91                    | 85   | 44   | G+, D-                  | CX: GGO          | 36/n.p.                                | TBB: A, G                |
| 12       | 79               | 49   | 90                    | 62   | 56   | G-, D+                  | CX: GGO          | 65/0.2                                 | n.p.                     |
| 13       | 126              | 87   | 90                    | 89   | 65   | G-, D+                  | HRCT: F, GGO     | 45/0.7                                 | n.p.                     |
| Average  | 81.8             | 69.7 | 90.4                  | 77.8 | 46.7 |                         |                  | 53/1.0                                 |                          |

G = Goose, D = duck; GGO = ground-glass opacities; TBB = transbronchial lung biopsy; A = lymphocytic alveolitis; G = granuloma; BOOP = bronchiolitis obliterans organizing pneumonia; F = fibrosis; TB = traction bronchiectasis; SLB = surgical lung biopsy; UIP = usual interstitial pneumonia; CX = chest x-ray; n.p. = not performed.

Management of all patients included complete avoidance of feather duvets, pillows and other avian antigens. Additionally, a short-term systemic corticosteroid therapy (oral prednisolone, 40 mg daily, tapered over 6–12 weeks) was started in all cases. Complete recovery was observed in 7 cases (No. 1, 3, 4, 6, 9, 11 and 12). In the other 6 cases (No. 2, 5, 7, 8, 10 and 13), all with radiological evidence of fibrosis on HRCT, clinical symptoms improved, but all still showed hypoxemia during exercise at follow-up.

All cases with fibrosis on HRCT and persistent hypoxemia on exercise were classified as ‘chronic EAA’, whereas the other cases were classified as ‘acute EAA’.

## Discussion

In the present study, the specific history and clinical characteristics of patients with FDL were comprehensively evaluated. All patients developed their symptoms after sleeping with pillows or duvets. The predominating symptoms were dyspnea (during exercise) and dry cough, followed by fever, night sweats and weight loss, which are typical flu-like symptoms of EAA.

In 1960, Plessner [22] reported for the first time an occupational disease affecting 31 workers in the feather in-

dustry and called it ‘duck fever’. Workers sorting the raw duck feathers were heavily exposed to feather dust and complained mainly of dry cough, dyspnea and fever. Further clinical investigation of these cases was not carried out. Since that time only a few further case studies have been published [14, 15, 23–26]. Table 3 summarizes the characteristics of these 15 previously reported cases.

Detection of antigen-specific IgG antibodies is one of the most significant predictors for the clinical diagnosis of EAA [7]. The immunological examinations showed in all the present cases specific IgG antibodies against goose or duck feathers, the putative antigen source. These specific IgG antibodies were also detected in most of the reported case studies of FDL [15, 23, 24]. Inase et al. [14] reported 7 cases of FDL and found positive specific IgG antibodies against pigeon dropping extract in 4 cases and against a feather mix in 2 cases, but he did not test for specific IgG antibodies against goose or duck feathers.

In the same case study it was found that 5 of 7 patients had a history of bird exposure prior to symptom onset and this might be the primary sensitization to avian antigens. In the present study only 5 of 13 patients had a prior history of bird exposure; however, in 4 cases it was at least 8 years prior to the current symptom onset.

In 1 case FDL could be explained as a relapse after diagnosis of BFL. A diagnosis of acute BFL had been made

**Table 3.** Summary of 15 previously reported cases with FDL

| First author  | Pa-tient n | Symptoms related to feather duvets                                                                                                                        | History of bird keeping                                                                            | Specific IgG antibodies                                                                                                                 | Radiology                                                                                                                                                                                                                                     | BAL with lymphocytosis >15%                                    | Histopathology                                                                                                                                       | Inhalative challenge with feathers                                                                                |
|---------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| Schiele [25]  | 1          | Dyspnea and fever after working in a laundry for feather duvets                                                                                           | No                                                                                                 | Positive for budgerigar and hen; n.p. for goose and duck feathers                                                                       | Chest roentgenogram with a ground-glass and a reticulonodular pattern                                                                                                                                                                         | n.p.                                                           | n.p.                                                                                                                                                 | Shivering and fever after 10 min inhalation with feather mix from the laundry                                     |
| Burdon [23]   | 1          | Nocturnal dyspnea and nonproductive cough after sleeping with new feather-filled pillows; weight loss of 5 kg in 8 weeks                                  | No                                                                                                 | Positive for feather extract (feather mix: chicken, duck and goose)                                                                     | Chest roentgenogram with a reticulonodular pattern in the lower zone                                                                                                                                                                          | Yes, 20% lymphocytes                                           | Collapsed alveoli with considerable infiltration of the alveolar walls by chronic inflammatory cells, fibrous tissue and giant cells                 | n.p.                                                                                                              |
| Haitjema [15] | 1          | Dyspnea, fever and weight loss of 4 kg; duvet and pillow filled with goose feathers for the past 4 years                                                  | No                                                                                                 | Positive for budgerigar, pigeon, parrot, canary and strongly for goose feathers                                                         | Chest roentgenogram with a reticulonodular pattern in the lower zone                                                                                                                                                                          | Yes, 70% lymphocytes                                           | n.p.                                                                                                                                                 | Reexposure to own duvet and pillow with shortness of breath, cough and fever after 6 h                            |
| Kim [26]      | 1          | Fatigue, fever, cough and weight loss; using 2 feather down comforters for the previous 3 years                                                           | Next door neighbor had canaries for the previous 11 years                                          | Positive for pigeon, parakeet and feather mix                                                                                           | Chest roentgenogram with a diffuse, bilateral reticulonodular pattern                                                                                                                                                                         | n.p.                                                           | Chronic interstitial pneumonitis with noncaseating granulomas and giant cells                                                                        | n.p.                                                                                                              |
| Kroidl [24]   | 4          | All with dyspnea, 2 with fever, 1 with weight loss; all symptoms associated with exposure to (new) feather duvets or pillows                              | No                                                                                                 | Positive for goose and/or duck feathers in 3 cases                                                                                      | In 3 cases chest roentgenogram with ground-glass and reticular pattern                                                                                                                                                                        | Yes, in all cases (80, 80, 72 and 45% lymphocytes)             | Performed in 2 cases with detection of lymphocytic alveolitis and in 1 case with granulomas and giant cells                                          | n.p.                                                                                                              |
| Inase [14]    | 7          | All with dyspnea and cough and 3 additionally with fever; 6 had contact with (new) feather duvets at home, 1 at a manufacturing company of feather duvets | 4 had a history of own bird breeding and 1 with environmental exposure to pigeons at his workplace | Positive for PDE in 4 cases, and for feather mix in 2 cases; specific IgG antibodies against goose and duck feathers were not performed | In all cases HRCT was performed with the following features: centrilobular nodules (6), ground-glass opacities (6), interlobular thickening (4), intralobular lines (4), traction bronchiectasis (3), honey combing (2) and consolidation (2) | Yes, in all cases (96, 91, 87, 77, 39, 21 and 21% lymphocytes) | 4 acute cases with alveolitis, 3 chronic cases with fibrosis around the bronchioles and the subpleural area; in all 7 cases no granulomas were found | In 4 cases an inhalation test with PDE was positive and in 4 cases an environmental provocation test was positive |

n.p. = Not performed; PDE = pigeon dropping extract.

8 years previously and no clinical signs of chronic BFL existed prior to symptom onset. In a similar case [16], an acute exacerbation of chronic BFL had been reported due to the use of a feather duvet.

Two other interesting new features were found when looking at the history of patients with FDL. On the one hand, some patients had filled their pillows with raw goose feathers from their own goose farms, which means that the feathers were not industrially processed and thus not cleaned. On the other hand, some patients had reported intensive contact with goose feathers in their youth when they had to pluck them, even after complaining of typical EAA symptoms.

This specific history of plucking goose feathers in their youth as well as making the beds at home is typical for women and therefore could be an explanation for the female predominance among patients with FDL. In the other subgroups of EAA the gender-specific differences of sensitization depend on the specific antigen exposure as well [19, 20].

Other clinical findings were typical for EAA, such as a mild restrictive pattern in lung function, moderate to severe reduced diffusion capacity, marked lymphocytic alveolitis in BAL with a low CD4/CD8 ratio of lymphocytes and a dominating ground-glass pattern in HRCT of the chest [8]. Interestingly, in HRCT additional fibrotic lesions were detected in 6 cases indicating a chronic course of EAA. These findings were consistent with the findings from Inase et al. [14], where a chronic course of FDL was reported in 3 out of 7 patients. In the case with a short period of time between exposure and symptoms (No. 13) the fibrotic findings in HRCT could be due to a prior BFL.

In 1 case, the histopathologic result of an open lung biopsy was a UIP pattern. It is known that in patients with an insidious chronic course of BFL a UIP pattern can

be the predominant histopathologic finding [10]. Other findings of lung tissue biopsy specimens in our study were lymphocytic alveolitis, loosely organized granulomas and a bronchiolitis obliterans organizing pneumonia-like pattern, which are typical for EAA [27].

We performed an inhalation challenge with feathers from the patients' own pillows in 3 cases to verify the diagnosis. The tests were carried out in a clinical setting where the patients had to toss the feathers for 30–60 min. Schiele and Lutgen [25] performed an inhalation challenge of 10 min with a feather mix from a laundry for feather duvets. Haitjema et al. [15] reexposed a patient overnight by having her sleep with her own duvet and pillow. Inase et al. [14] performed inhalation challenges in 4 out of 7 cases with pigeon dropping extract and not with feathers from the patients' own pillows or duvets. In the other cases an environmental provocation test was performed but not explained in detail. We believe that the above-described inhalation challenge with the tossing of feathers from the patients' own pillows is a practical and feasible method and analogous to the reported standardized inhalation challenges with hay in cases of farmer's lung [28, 29].

In conclusion, this study presents the specific history and clinical findings of patients with FDL. It is a rare subspecies of BFL, where patients have recurrent symptoms after sleeping with pillows or duvets. These patients have specific IgG antibodies against goose or duck feathers and typical EAA features of lung function, HRCT, BAL and lung biopsy specimens. An acute or a chronic course may be seen. Beside a history of sleeping with feather duvets, physicians additionally should ask about prior bird antigen exposure even without clinical symptoms, sleeping with raw, nonindustrially processed feathers, or intensive contact with goose or duck feathers in their youth.

## References

- 1 Patel AM, Ryu JH, Reed CE: Hypersensitivity pneumonitis: current concepts and future questions. *J Allergy Clin Immunol* 2001;108: 661–670.
- 2 Lacasse Y, Selman M, Costabel U, Dalphin JC, Morell F, Erkinjuntti-Pekkanen R, Mueller NL, Colby TV, Schuyler M, Jomphe V, Cormier Y: Classification of hypersensitivity pneumonitis. A hypothesis. *Int Arch Allergy Immunol* 2009;149:161–166.
- 3 Terho EO: Diagnostic criteria for farmer's lung disease. *Am J Ind Med* 1986;10:329.
- 4 Richerson HB, Bernstein L, Fink JN, Hunninghake GW, Novey HS, Reed CE, Salvaggio JE, Schuyler MR, Schwartz HJ, Stechschulte DJ: Guidelines for the clinical evaluation of hypersensitivity pneumonitis. *J Allergy Clin Immunol* 1989;84:839–844.
- 5 Schuyler M, Cormier M: The diagnosis of hypersensitivity pneumonitis. *Chest* 1997; 111:534–536.
- 6 Sennekamp J, Müller-Wening D, Amthor M, Baur X, Bergmann KC, Costabel U, Kirsten D, Koschel D, Kroidl R, Liebetrau G, Nowak D, Schreiber J, Vogelmeier C: Guidelines for diagnosing extrinsic allergic alveolitis. German Extrinsic Allergic Alveolitis Study Group. *Pneumologie* 2007;61:52–56.
- 7 Lacasse Y, Selman M, Costabel U, Dalphin JC, Ando M, Morell F, Erkinjuntti-Pekkanen R, Müller N, Colby TV, Schuyler M, Cormier Y, HP Study Group: Clinical diagnosis of hypersensitivity pneumonitis. *Am J Respir Crit Care Med* 2003;168:952–958.

- 8 Selman M: Hypersensitivity pneumonitis: a multifaceted deceiving disorder. *Clin Chest Med* 2004;25:531–547.
- 9 Ohtani Y, Saiki S, Sumi Y, Inase N, Miyake S, Costabel U, Yoshizawa Y: Clinical features of recurrent and insidious chronic bird fancier's lung. *Ann Allergy Asthma Immunol* 2003;90:604–610.
- 10 Ohtani Y, Saiki S, Kitaichi M, Usui Y, Inase N, Costabel U, Yoshizawa Y: Chronic bird fancier's lung: histopathological and clinical correlation. An application of the 2002 ATS/ERS consensus classification of the idiopathic interstitial pneumonias. *Thorax* 2005;60:665–671.
- 11 Sennekamp HJ: Bird breeder's lung; in Sennekamp HJ (ed): *Extrinsic Allergic Alveolitis/Hypersensitivity Pneumonitis*, ed 1. Munich, Dustri Verlag, 2004.
- 12 Meyer FJ, Bauer PC, Costabel U: Feather wreath lung: chasing a dead bird. *Eur Respir J* 1996;9:1323–1324.
- 13 Luksza AR, Bennett P, Earis JE: Bird fancier's lung: hazard of the fishing industry. *Br Med J* 1985;291:1766.
- 14 Inase N, Ohtani Y, Sumi Y, Umino T, Usui Y, Miyake S, Yoshizawa Y: A clinical study of hypersensitivity pneumonitis presumably caused by feather duvets. *Ann Allergy Asthma Immunol* 2006;96:98–104.
- 15 Haitjema T, van Velzen-Blad H, van den Bosch JM: Extrinsic allergic alveolitis caused by goose feathers in a duvet. *Thorax* 1992;47:990–991.
- 16 Inase N, Sakashita H, Ohtani Y, Sogou Y, Sumi Y, Umino T, Usui Y, Yoshizawa Y: Chronic bird fancier's lung presenting with acute exacerbation due to use of a feather duvet. *Intern Med* 2004;43:835–837.
- 17 McSharry C, Dye GM, Ismail T, Anderson K, Spiers EM, Boyd G: Quantifying serum antibody in bird fancier's hypersensitivity pneumonitis. *BMC Pulm Med* 2006;6:16–24.
- 18 Ouchterlony O: *Handbook of Immunodiffusion and Immunoelectrophoresis*, ed 1. Ann Arbor, Arbor Science Publishing, 1968, pp 4–47.
- 19 Ando M, Arima K, Yoneda R, Tamura M: Japanese summer-type hypersensitivity pneumonitis. *Am Rev Respir Dis* 1991;144:765–769.
- 20 Terho EO, Heinonen OP, Lammi S: Incidence of clinically confirmed farmer's lung disease. *Am J Ind Med* 1986;10:330.
- 21 Bergmann KC, Kroidl R, Liebetrau G, Müller-Wening D, Sennekamp J, Vogelmeier C: Empfehlungen zur inhalativen Provokationstestung bei exogen-allergischer Alveolitis. *Arbeitsgruppe exogen-allergische Alveolitis der Deutschen Gesellschaft für Pneumologie. Pneumologie* 1998;52:444–446.
- 22 Plessner MM: A disease of feather sorters: duck fever. *Arch Mal Prof* 1960;21:67–69.
- 23 Burdon JGW, Stone C: Bird fancier's lung after an unusual exposure to avian protein. *Am Rev Respir Dis* 1986;134:1319–1320.
- 24 Kroidl RF, Wiehammer S, Sennekamp J: Bed feathers alveolitis: 4 particular cases. *Allergologie* 2003;8:334–339.
- 25 Schiele R, Lutgen W: Berufsbedingte allergische Alveolitis beim Umgang mit Bettfedern. *Arbeitsmed Sozialmed Präventivmed* 1978;13:36–39.
- 26 Kim KT, Dalton JW, Klaustermeyer WB: Subacute hypersensitivity pneumonitis to feathers presenting with weight loss. *Ann Allergy* 1993;71:19–23.
- 27 Reyes CN, Wenzel FJ, Lawton BR, Emanuel DA: The pulmonary pathology of farmer's lung. *Chest* 1982;81:142–146.
- 28 Hendrick D, Marshall R, Faux J, Krall J: Positive 'alveolar' responses to antigen inhalation provocation tests: their validity and recognition. *Thorax* 1980;35:415–427.
- 29 Vogelmeier C, Krombach F, Münzing S, König G, Mazur G, Beinert T, Fruhmans G: Activation of blood neutrophils in acute episodes of farmer's lung. *Am Rev Respir Dis* 1993;148:396–400.