SQUAWKS IN PNEUMONIA
Rozanne Paciej, Andrey Vyshevskiy, PhD, Dhireendra Bana, MD, and Raymond Murphy, MD; Faulkner/Brigham and Women Hospitals, Boston, MA, USA

BACKGROUND
Squawks are short, inspiratory, musical sounds that have been reported to be present in patients with hyperreactivity pneumonitis and fibrotic lung disorders. We have noticed squawks in patients with pneumonia, but could find little in the medical literature on their presence in this disorder.

PURPOSE
Our purpose was to examine the prevalence of squawks in patients with pneumonia and to compare this prevalence with that found in normals and in patients with a variety of other illnesses.

MATERIALS AND METHODS
Seventy-eight patients with a clinical diagnosis of pneumonia and 427 other subjects who were either normal or who had another diagnosis were included in the study. We used a 16 channel lung sound analyzer (Stethographic Model 1602) to record their lung sounds.

A soff test pad with acoustic chest pieces imbedded in it was placed on the backs of the subjects while they were lying in the supine position.

Two experienced observers, blinded to the clinical diagnosis, used play back and video displays to identify squawks.

Patients with at least one squawk as defined unanimously by two experienced observers were considered squawk positive.

RESULTS
Squawks were present in:
- 12 of 78 patients with pneumonia (15%)
- 9 of the 223 normal subjects (8%)
- 4 of the 18 patients with IPF (22%)
- 2 of the 41 patients with bronchial asthma (5%)
- 1 of the 79 patients with COPD (1%)
- 9 of 56 patients with congestive heart failure (16%)  

In the pneumonia patients the squawks were:
- Mid-inspiratory in five patients
- End-inspiratory in five patients
- In two of the patients squawks were present both in mid- and end-inspiration.
- In 9 of the 12 patients with pneumonia, the squawks were in the same location as the roentgenographic opacifications.
- In all 12 patients with pneumonia the squawks were in the middle or lower lung regions; none were heard over the upper lung.
- The only patients with squawks detected over the upper chest were one asthmatic and one patient with radiation pneumonitis.

Figure 2. The time-amplitude plot of a sound recorded at lung bases posteriorly (channel 14) in a patient with pneumonia. Waveforms are presented in both the unexpanded (A) and expanded (B) modes.

A: The unexpanded waveform shows one full breath. The solid bars under the unexpanded wave mark the respiratory cycle; the light bar indicates inspiration and the dark bar indicates expiration. Abnormal sounds are indicated as follows: 's' stands for fine crackle, 'v' indicates squawk, 'n' stands for normal inspiratory sound.

B: The squawk waveform is shown expanded.

C: The squawk in the frequency domain. The squawk sound was end-inspiratory with a frequency peak at 600 Hz. In this patient similar squawks appeared in 3 consecutive breaths during the 20 seconds of deeper than normal breathing.

Figure 3. Typical squawk waveforms. Bars under the waveforms indicate intervals that were used to calculate the representation of the squawk in the frequency domain (insets on the right).

Figure 4. Example of transmission of a squawk through the chest. Time-amplitude plots of a single breath are displayed as they appear at multiple sites. Waveforms are presented in both the unexpanded (top) and expanded (bottom) modes. The unexpanded waveform shows one full breath. The solid bars under the unexpanded waves mark the respiratory cycle; light bars indicate inspiration and dark bars indicate expiration. The arrow indicates the location of the expanded interval. The duration of the expanded interval is 50 milliseconds.

A: In this subject with pneumonia, the squawk is most prominently detected on channel 5. Note that the squawk sound is also present on channels 3, 4, and 6. A similar squawk in the same location was heard on every breath we examined.

B: The same squawk as in A is shown in the frequency domain. The squawk frequency was 644 Hz.

CONCLUSION
We developed an algorithm for automatic detection of squawks based on their known acoustic characteristics described above. We compared the results of the computerized detection to that of detection by the two blinded observers in these 587 subjects. Patients with at least one squawk as defined unanimously by the observers were considered squawk positive. The sensitivity of the computerized detection of squawk positive patients was 0.79, the specificity was 0.86, the positive predictive value was 0.86.

Computerized identification of squawks
- Short inspiratory wheeze-like sounds are found in pneumonia.
- The other phenomena that can cause them are chronic restrictive disorders and are relatively uncommon as compared to pneumonia.
- When evidence of these restrictive disorders is not present and an acute syndrome consistent with respiratory infection is present, the presence of squawks can provide relatively specific, although not sensitive evidence of pneumonia.

Case Report
Squawk leading to the correct diagnosis
- 69-year-old female presented to the emergency room with acute shortness of breath
  - General good health, physically active
  - 20 pack-year history of cigarette smoking, stopped 18 years previously
  - Cough of 2 month duration with progressive dyspnea
  - Negative allergy tests, but started on bronchodilators for a presumptive diagnosis of new onset asthma
  - Physical exam in ER - Cylindric female in acute respiratory distress, T 99.8, Pulse 107, Respiratory rate 22
  - Chest auscultation - mild wheezing, few inspiratory crackles
  - Chest Xray interpreted as normal
  - Diagnosis acute bronchial asthma
  - Rx steroids IV, bronchodilators
  - Automated lung sound analysis - 3 hours after admission to ER - 4 crackles per breath, squawks present
  - Because of the squawks antibiotic Rx instituted
  - Re-reading of chest Xray - small patch of opacification consistent with pneumonia - cleared on follow-up exam
  - Squawk localized to area of Xray abnormality