Otitis Media with Effusion in Aircrew Members

José Antônio Pinto; Heloisa dos Santos Sobreira Nunes; Rozania Soeli dos Santos; André Cavallini; Gabriel Freitas; Davi Knoll; Cauê Duarte

BACKGROUND: Middle-ear barotrauma is a common problem reported by aircrew members and passengers. Studies have shown that 20–50% of passengers report ear complaints during the flight or after landing. The aim of this study is to determine the prevalence of otitis media with effusion in aircrew members and describe the time to resolution of the condition.

METHODS: All aircrew members presenting at Civil Aviation Center at Congonhas Airport at São Paulo for annual flight medical examinations from September 2014 to May 2015 were reviewed retrospectively for the presence of otologic disorders. Eligible participants were all pilots, copilots, and flight attendants with a diagnosis of otitis media with effusion confirmed by immittance testing.

RESULTS: Of 1607 aircrew members, 155 (9.65%) were diagnosed as having otitis media with effusion. Most participants were men (51.6%). Regarding aircrew position, 81.9% were flight attendants, 11.6% were copilots, and 6.5% were pilots. The mean time to resolution of the otitis media was 8.23 ($\pm$ 3.02) days.

DISCUSSION: Otolaryngologists must be aware of the effects of gas expansion in the middle ear at higher altitudes for the appropriate treatment of diseases related to pressure changes. The recommendation for an aircrew member to return to flying duties should occur only after the individual has been treated and complete resolution, confirmed by immittance testing, has been documented.

KEYWORDS: aerospace medicine, altitude, otitis media with effusion, sick leave.

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The development of problems related to middle-ear pressure equalization is common during air travel. The first report of the adverse effects of changes in ambient pressure dates from 1660, when Boyle published the first experimental work related to decompression, in which he reported that a reduction in ambient pressure could lead to bubble formation in living tissues.[13] Commercial airplanes cruise normally at an altitude between 30,000 and 40,000 ft (9150 and 12,200 m), and cabin pressure is equivalent to that of an altitude of 8000 ft (564 mmHg/2438 m). Low cabin pressure leads to a fall in oxygen saturation levels (to about 90%) and expansion of gases. According to Boyle's law, gases expand up to 35% when ascending from sea level to 8000 ft of altitude.[4] Under these conditions, failure of the Eustachian tube to equalize the pressure within the middle ear and the environment can lead to barotrauma.[5]

Rapid alterations in atmospheric pressure, such as when an airplane ascends or descends, require healthy ears to equilibrate over- and underpressures. Congestion of the respiratory mucosa of the nose, nasopharynx, and Eustachian tube due to an upper respiratory tract viral infection, for example, can lead to a more severe middle-ear barotrauma.[5] In more severe cases of barotrauma, the middle ear can fill with clear fluid as the Eustachian tube attempts to equalize the pressure difference. If the Eustachian tube fails to open, clearance is impaired, which may lead to otitis media with effusion (OME).

In civil aviation, any alterations in ambient pressure that can occur during airplane flying are extremely important, because they can result in pathological changes that may render aircrew members unable to work. Federal Aviation Regulations in Brazil require aircrew members to have periodic flight medical

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examinations that include assessment of the otorhinolaryngological system in relation to their aviation duties. If the examiner detects any abnormality of the system that can affect the regular and safe performance of duties, such as OME, aircrew members will be considered 'temporarily unfit'. In this case, they are released from work for treatment, remaining off duty until resolution of the condition has been achieved. The present study aimed to determine the prevalence of OME in aircrew members of commercial airlines and describe the time to resolution of the condition.

METHODS

This was a review of case series of aircrew members recruited from the Civil Aviation Medical Center at Congonhas Airport, São Paulo, Brazil. Congonhas Airport is one of the four commercial airports serving São Paulo and all major Brazilian airlines are headquartered on the outskirts of this airport.

Subjects

All aircrew members presenting for annual flight medical examinations from September 27, 2014, to May 29, 2015, in the Civil Aviation Medical Center at Congonhas Airport were retrospectively identified and analyzed for the presence of otologic disorders, including symptomatic patients with sinusitis, nasal obstruction ear pain, and capped ear sensation. Eligible participants were all pilots, copilots, and flight attendants with a diagnosis of OME or serous otitis media confirmed by immittance testing with curve B. OME was defined as the presence of middle-ear effusion without signs or symptoms of acute infection and confirmed by immittance test with curve B. Exclusion criteria were the presence of perforation of the tympanic membranes, chronic otitis media, or acute otitis media.

All aircrew members were exposed to the same cabin environmental conditions and had a similar number of flight hours, with a maximum of 4–5 landings per day. All participants were assessed by immittance testing, using the same immittance meter, for monitoring of middle ear status and determining the time required to regain fitness and return to full activity. The patient was eligible to come back to work if the curve returned from B to A. The immittance testing was repeated 5 d from diagnosis and treatment with corticosteroids and nasal vasoconstrictor. The outcome of interest was length of time absent from work until a fully sustained return to work, expressed as 'duration of sick leave' in days.

The study was approved by the Research Ethics Committee of Sociedade Beneficiente São Camilo (registration number: 60,975,737). Informed consent was waived due to the case series design of the study and retrospective nature of data collection. All investigators signed a data use agreement to ensure the ethical and secure use of the data.

Statistical Analysis

Continuous variables were expressed as mean and standard deviation (SD), median and interquartile range, and minimum and maximum values. The normality of data was assessed by visual inspection of histograms and using the D'Agostino and Pearson omnibus normality test. Categorical variables were expressed as absolute and relative frequencies. Means were compared in groups of two and three variables using Student's *t*-test and analysis of variance (ANOVA), respectively. Univariate binary logistic regression analysis was performed to evaluate factors (used as covariables) associated with duration of sick leave (binary variable of interest). The crude odds ratio (OR) with 95% confidence interval (95%CI) was calculated for each variable. Statistical analysis was performed using the R-development Core Team software, version 3.3.1 (R Foundation for Statistical Computing, Vienna, Austria). A two-tailed P-value < 0.05 was considered statistically significant for all analyses.

RESULTS

Starting from the total of 1607 participants, 1278 (79.52%) were flight attendants, 162 (10.08%) copilots, and 167 (10.39%) pilots. During the study period, 155 out of 1607 aircrew members (9.65%) were diagnosed as having OME during their annual flight medical examinations by the immittance test with curve B (**Table I**). Of these, 51.6% were men and 48.4% were women. Some aircrew members presented with hearing loss, aural fullness, and nasal obstruction as symptoms of OME. Regarding aircrew position, 81.9% were flight attendants, 11.6% were copilots, and 6.5% were pilots. The mean (SD) time to resolution of the OME was 8.23 (3.02) days.

The mean duration of sick leave in days was compared between the participants divided into groups according to sex and aircrew position (**Table II**). There was no significant association between variables in any of the comparisons. The mean duration of sick leave was 8.6 d for pilots, 8.35 d for flight attendants, 7.2 d for copilots, 8.3 d for women, and 8.1 d for men.

Duration of sick leave was dichotomized at the 66th percentile of this variable, which was 9 d ($\leq$ 9 d: no event; $>$ 9 d: event; **Table III**). Duration of sick leave $>$ 9 d showed no association with the covariables included in the binary logistic regression analysis. The duration of sick leave was more than 9 d in 50% of pilots, 28.2% of flight attendants, and 16.7% of copilots.

Table I. Characteristics of Study Participants.

VARIABLE	STATS
Duration of sick leave, days	
Mean ± SD (*N*)	8.23 ± 3.02 (145)
Median (Q1–Q3)	8.00 (6.00–10.00)
Minimum–maximum	1–22
Female, *N* (%)	75 (48.4%)
Male, *N* (%)	80 (51.6%)
Total	155
Aircrew position, *N* (%)	
Pilot	10 (6.5%)
Flight attendant	127 (81.9%)
Copilot	18 (11.6%)
Total	155

SD, standard deviation; Q1, first quartile; Q3, third quartile.

Table II. Results of the Comparison of Mean Duration of Sick Leave (in Days) Between the Participants Divided into Groups According to Aircrew Position and Sex.

VARIABLE & GROUP	*N*	MEAN	SD	95%CI	*P*-VALUE
Sick leave, days: aircrew position					
Pilot	10	8.6	2.989	(6.462; 10.74)	0.3078
Flight attendant	117	8.359	3.142	(7.784; 8.934)	
Copilot	18	7.222	1.957	(6.249; 8.195)	
Sick leave, days: sex					
Female	69	8.304	2.876	(7.613; 8.995)	0.7916
Male	76	8.171	3.16	(7.449; 8.893)	

SD, standard deviation; 95%CI, 95% confidence interval.

DISCUSSION

Middle-ear barotrauma is a common problem reported by aircrew members and passengers. Studies have shown that 20–50% of passengers report ear complaints during the flight or after landing.[3,10,11] In the present study, of the total of 1607 participants, 10.8% were copilots, 10.39% were pilots, and 79.52% were flight attendants. We studied 9.65% of aircrew members who developed OME, as detected in their annual flight medical examinations.

The health and comfort of air travelers are affected by the environment created in cabins.[2,8] During ascent and descent, the cabin pressure changes by up to 200 mmHg (267 mbar).[4] The decrease in cabin pressure during ascent creates relative overpressure in the middle ear and passive opening of the Eustachian tube equalizes the pressure difference between the nasopharynx and the middle ear. However, the increase in cabin pressure during descent creates relative middle-ear underpressure that must be actively equalized. Under physiological conditions, this is achieved by swallowing, yawning, or other active pressure equalizing maneuvers. If pressure equalization is not achieved, a middle-ear barotrauma can occur.[5] Also, continued exposure to low humidity leads to discomfort through drying of the skin and mucosa.[7] The optimal relative humidity for comfort ranges from 40 to 70%.[9] At cruise altitudes, cabin humidity depends on passenger load. It normally ranges from 5 to 20%, but it can reach a level as low as 2%.[6] Low humidity interferes with the normal flexibility of the tympanic membrane, decreasing its buffering capacity as pressure changes. This factor may further aggravate an already existing condition, such as OME.[7]

Table III. Results of Univariate Binary Logistic Regression Analysis to Evaluate Factors Associated with Duration of Sick Leave > 9 d.

VARIABLE	SICK LEAVE ≤ 9	SICK LEAVE > 9	OR	95%CI		*P*-VALUE
Sex						
Female	48 (69.6%)	21 (30.4%)	1.0 (Ref.)			
Male	56 (73.7%)	20 (26.3%)	0.816	0.396	1.683	0.5825
Total	104	41				
					2.17	0.9597
Aircrew position						
Pilot	5 (50.0%)	5 (50.0%)	5	0.866	28.861	0.072
Flight attendant	84 (71.8%)	33 (28.2%)	1.964	0.534	7.232	0.31
Copilot	15 (83.3%)	3 (16.7%)	1.0 (Ref.)			
Total	104	41				

OR, odds ratio; 95%CI, 95% confidence interval.

With respect to the ear, nose, and throat (ENT) requirements established in the Brazilian Federal Aviation Regulations, aircrew members are considered fit to fly if they do not have: 1) any abnormality or disease of the ear or related structures, any nasal obstruction or any malformation or disease of the buccal cavity or upper respiratory tract that may interfere with the safe exercise of the applicant's license and rating privileges; 2) any speech or hearing disorders sufficiently severe to cause impairment of communication; or 3) any disturbance of vestibular function, significant dysfunction of the Eustachian tubes, or unhealed perforation of the tympanic membranes. A single dry perforation of the tympanic membrane does not render the applicant unfit. In the case of OME, aircrew members are not permitted to fly until complete resolution of the condition because the degree of discomfort caused by the OME may affect the safe performance of duties and, consequently, jeopardize flight safety. Secretions in the middle ear and obstruction of the Eustachian tube impair adequate pressure equalization with changing altitude, which may also reduce performance.[1] Therefore, designated aviation medical examiners must be familiar with the wide variety of possible causes of aircrew incapacitation, so as to enable an adequate assessment and prompt treatment to reduce discomfort and the other incapacitating symptoms that can interrupt work productivity.

In the present study, pilots stayed away from work, on average, for 8.6 d, copilots for 7.2 d, and flight attendants for 8.2 d. Of the pilot group, 50% took more than 9 d of sick leave, while the copilot group had only 16.7% more than 9 d and 28.2% of flight attendants took more than 9 d. The total number of pilots (167) and copilots (162) are very close, so the result of the time of sick leave is not well explained. We agree that this result is probably related because of their small number (10 pilots with OME); it is statistically more likely that their numbers would have a larger variance. Further studies with a larger number of patients are needed to assess these issues. It is worth noting that aircrew members should not fly while under treatment with first-generation antihistamines, because they can cause drowsiness that may affect aviation-related cognitive skills. Therefore, aircrew members cannot work for 12 to 24 h after intake of the drug. However, there is evidence that the use of fexofenadine, a second-generation antihistamine, does not affect performance related to flight activities.[14] Other contraindicated medications include systemic corticosteroids, topical nasal decongestants (due to adrenergic effects), antibiotics and bactericides, and nonsteroidal anti-inflammatory drugs (due to decreased reflexes and drowsiness). Aircrew members cannot work for 12 to 18 h after intake of these drugs. Therefore, the type of medication

used influences the duration of treatment and, consequently, the duration of sick leave.

Immittance testing is an important tool for both the diagnosis and follow-up of patients with OME. In the present study, all participants were assessed by immittance testing at the beginning and end of treatment. At the end of treatment, a type A curve indicates that the aircrew member is able to resume flying duties. Tympanometry is used to determine the status of the middle ear and can be useful in assessing Eustachian tube function. Most normal aviators and patients with chronic otitis media in remission show a type A tympanogram, while type B and type C tympanograms are characteristic of acute otitis media.[12]

A limitation of the study is that this case series was performed at a single medical center, which might limit the generalizability of the findings. Because our results derive from a specific population, they might not be applicable to the population of air travelers at large. This is a pilot study in this population and future articles with a larger number of participants may help in the comparison of this disease.

It is extremely important that otolaryngologists are aware of the effects of gas expansion in the middle ear at higher altitudes for the appropriate treatment of diseases related to pressure changes. According to the Brazilian National Civil Aviation Agency, aircrew members are considered unfit for their flying duties while under treatment for OME due to the risk of complications and to protect flight safety. It is essential that the recommendation for an aircrew member to return to flying duties occur only after the individual has been treated and complete resolution, confirmed by immittance testing, has been documented.

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