

REVIEW

Open Access



In-flight allergic emergencies

Mario Sánchez-Borges^{1,17*}, Victoria Cardona^{2,3}, Margitta Worm⁴, Richard F. Lockey⁵, Aziz Sheikh⁶, Paul A. Greenberger⁷, Ignacio J. Ansotegui⁸, Motohiro Ebisawa⁹, Yehia El-Gamal¹⁰, Stanley Fineman¹¹, Mario Geller¹², Alexei Gonzalez-Estrada¹³, Luciana Tanno^{14,15}, Bernard Y. Thong¹⁶ and on behalf of the WAO Anaphylaxis Committee

Abstract

Allergic and hypersensitivity reactions such as anaphylaxis and asthma exacerbations may occur during air travel. Although the exact incidence of in-flight asthma and allergic emergencies is not known, we have concerns that this subject has not received the attention it warrants. There is a need to provide passengers at risk and airlines with the necessary measures to prevent and manage these emergencies. A review of the epidemiology, management and approaches to prevention of allergic and asthma emergencies during air travel is presented with the goal of increasing awareness about these important, potentially preventable medical events.

Keywords: Aircraft, Air travel, Allergic reaction, Anaphylaxis, Asthma, Emergency, Flight, Food allergy

Background

About 2.75 billion passengers are transported worldwide by airlines every year. Many of these people will have pre-existing long-term conditions – including asthma and/or allergy – which put them at risk of an in-flight medical emergency. In a smaller minority of people, these conditions may develop for the first time (i.e. incident cases) while in flight. It is expected that by 2030, half of all aircraft passengers will be over 50 years of age [1]. Up to 44,000 in-flight medical emergencies occur each year [2], and data suggest that about 17% of such cases are transferred to a hospital, with 4% resulting in hospitalization or death.

Systemic allergic reactions (SAR) (a serious systemic allergic reaction is defined as anaphylaxis) and asthma exacerbations (AE) may occur during air travel. We have concerns that to date, these have not received sufficient attention from passengers, airlines, and the medical community. In view of the potentially avoidable morbidity and mortality, a review about the epidemiology, management and prevention of allergic and asthma emergencies during air travel is needed to increase awareness about these reactions and how to prevent and treat them. Likewise, travel for the allergic and asthmatic passenger poses a

number of problems, in particular for those with a history of a food-induced SAR or who have asthma. Patients may experience, among other, fear of suffering an allergic reaction or AE, problems regarding which medications to carry on board, how to use them, or not receiving appropriate attention when seeking support from airline personnel about their potential needs [3].

The frequency of these reactions among susceptible passengers is unknown; however, data from peanut allergic individuals indicate that approximately 9% of them have experienced some sort of allergic reaction during flights [4, 5].

Medical emergencies during air travel

In-flight medical emergencies occur in 1 per 11,000 passengers [6] or 1 in every 604 flights [2]. A number of reasons are proposed to explain the incidence of medical and allergic events during air travel, and those are summarized in Table 1. The most common in-flight medical events include syncope, gastrointestinal and cardiac problems [2, 7, 8].

Alterations in passenger cabin during flight: implications of physiological changes during air travel to allergic and hypersensitivity diseases

There are two major concerns about allergic and respiratory diseases when traveling by air. The first is related to the concentration of oxygen in the cabin. While in flight, the cabin pressure is equivalent to an altitude of 6000 to

* Correspondence: sanchezbmario@gmail.com

¹Allergy and Clinical Immunology Department, Centro Médico Docente La Trinidad, Caracas, Venezuela

¹⁷Clínica El Avila, 6a.transversal Urb. Altamira, piso 8, consultorio 803, Caracas 1060, Venezuela

Full list of author information is available at the end of the article



Table 1 Rick factors for medical and allergic events during air travel

An increase of passenger's age
Flight stress and anxiety, including increased security procedures
Disruption of routine
Changes in the cabin environment (temperature, humidity, air pressure)
Decreased seat space
Flight delays
Alcohol/drug intake
Longer flights
Altered circadian rhythm
Jet lag
Pre-existing medical conditions

8000 ft, exposing passengers to a partial pressure of arterial oxygen of 60 mm Hg compared to 75 to 100 mm Hg at sea level. Thus, the partial pressure of oxygen in the cabin air at cruising altitude is 25–30% lower than at sea level. A slight fall in oxygen blood saturation occurs, ranging from 92 to 95%, followed by compensatory hyperventilation and tachycardia [9]. These physical alterations may affect passengers who have cardiac, respiratory or hematologic (anemia) diseases, theoretically increasing the risk of exacerbations of allergic and hypersensitivity reactions such as anaphylaxis.

These pressure changes can also result in “blocked ears or sinuses” or, occasionally, barotitis or barosinusitis. These conditions can usually be prevented by yawning, chewing gum during the flight, and by using a sympathomimetic nasal spray such as oxymetazoline before ascent and descent.

The dry cabin atmosphere (with humidity 6–18%) can also irritate the mucosal membranes of the mouth and upper respiratory tract. Likewise, dehydration can occur, especially in a passenger taking a diuretic. Therefore, drinking plenty of extra fluids is recommended during flight [10].

Asthma and allergic reactions

Allergic reactions account for an estimated 2–4% of medical problems on board commercial airliners (Table 2) [5, 11–13]. Buehrle and Gabler observed that

Table 2 Prevalence of in-flight allergic reactions

Authors (year of publication)	Prevalence (%)	Reference
Szmajer et al. (2001) [13]	2.4	13
Delaune et al. (2003) [12]	2.8	12
Baltsezk (2008) [11]	3.7	11
Sand et al. (2012) [16]	2.2	17

“allergy” was the 7th most common cause of in-flight medical problems between 2002 and 2007, ranging from 1.5 to 2.5% [1]. During the same period asthmatic events were 14th in frequency (0.6 to 3.2%).

Some authors propose that an AE is the most common, and potentially the most life-threatening condition reported by major airlines. According to Dowdall's study, serious allergic reactions rarely occur. Respiratory events were the 5th cause of aircraft medical conditions, whereas allergic diseases, including urticaria, angioedema, additional forms of acute dermatitis, AE, and SAR were the 11th most common [6]. SAR in airplanes are most commonly triggered by foods (peanuts, tree nuts, and seafood) or medications. Very rarely these are triggered by insect stings or an insecticide spray [14].

There are reports of passengers having experienced idiopathic anaphylaxis while in flight, administering self-injected epinephrine (adrenaline) in the lavatory, and not notifying the flight attendant (Greenberger P, personal communication). There are also reports of attacks that have necessitated plane diversion to the closest airport.

Other publications report that allergic emergencies are responsible for 2.2% of all medical problems and result in 4.5% of aircraft diversions [2]. Allergic reactions were the 7th most frequent cause of medical events, and dermatologic manifestations, including skin rashes, the 9th most common cause in Baltsezk's study [11].

An article by Nable et al. on in-flight medical emergencies did not discuss allergic conditions or SAR, although it did mention a 12% incidence of “respiratory” reactions [8]. This prompted Casale and Lemanske to submit a letter to *The New England Journal of Medicine* highlighting the need to consider “anaphylaxis” as a reaction likely to occur during flights [15].

The lack of recognition of allergic reactions as an important cause of medical events during air travel could be due to the fact that they are rare, or because they are under-recognized, or diagnosed and not reported, since methods to report such reactions are different and not standardized [16, 17]. This is an area that therefore warrants further study. As previously stated, passengers often do not report medical problems during flight [5].

In-flight treatment of allergic emergencies and asthma

Treating medical emergencies during flight is a major challenge and air travel is an important concern for subjects with asthma and a history of a SAR.

The resources to treat allergic emergencies are somewhat limited. In the United States, the Federal Aviation Administration requires the inclusion of epinephrine in medical kits carried on board [18]. These emergency medical kits typically contain the following medications [19]:

- Aqueous epinephrine (adrenaline) 1:10000 and 1:1000 dilution.
- Albuterol (salbutamol) for nebulization.
- Bronchodilator aerosol inhaler.
- Cortisol (hydrocortisone).
- Antihistamines tablets and injectable (commonly diphenhydramine).

A recommendation from this World Allergy Organization (WAO) expert group for in-flight treatment of a SAR and AE is:

- a) For AE, inhaled bronchodilator and oxygen. Consider an oral, intramuscular or intravenous corticosteroid for moderate to severe symptoms and intramuscular epinephrine for severe symptoms.
- b) For mild, moderate, and severe SAR, intramuscular epinephrine 0.01 mg/kg up to 0.5 mg of 1:1000 solution IM in the anterior lateral thigh. Repeat as necessary.

Prevention

Food-induced SAR are increasingly being observed in many parts of the world. Strategies to reduce the risk of a SAR while traveling should begin during the early planning of the plane trip. Advice from their treating physician or allergist/immunologist should be obtained about preventive measures to be implemented before or during the flight. Likewise, a treatment plan should be instituted in case there is an inadvertent contact with a known allergen, i.e., a peanut [20–25].

Greenberger and Lieberman propose that subjects with idiopathic anaphylaxis not travel within a week of a previous episode and recommend the administration for an adult of prednisone 40–60 mg and an H1 antihistamine by mouth each morning for 1 week before travel. This can help reduce the frequency and severity of episodes [26]. If the flight is longer than 1 week after an episode of idiopathic anaphylaxis, empiric therapy should be initiated and continued to reduce the likelihood of an attack while in flight. For example, the passenger can be converted to alternate day prednisone.

Medical departments of major airlines can also be consulted about specific questions and recommendations for air flights on individual carriers. Physicians on board should be contacted immediately by the airline crew for any emergency, including allergic emergencies, to determine what treatment should be instituted and if the plane should be diverted to the nearest airport. In addition to medical kits on board and special training of the crew on the management of medical emergencies, airlines may have remote access to medical services which can monitor and give instructions for the

Table 3 Measures that reduce the risk of an in-flight reaction to peanut and tree nuts^a

1. Passengers requesting any kind of special accommodation (e.g., peanut/tree nut snacks not be distributed, announcement to not eat items with peanut/tree nut, request special peanut/tree nut-free meal, buffer zone, pre-board, request to sit in a certain seat/zone).
2. Peanut/tree nut-free meals.
3. Wiping of tray tables
4. Avoidance of airline pillows or blankets
5. Buffer zones around which peanut or nut products cannot be consumed
6. Request other passengers not to consume peanut/tree nut-containing products
7. Announcement that passengers do not eat peanut/tree nut containing goods
8. Not consuming airline-provided food

^aModified from reference [28]

Table 4 Airline policies for allergic passengers (Data from 13 air carriers)^a

	Number of airlines
Pre-boarding arrangements	
• Request a food “buffer zone”	5
• No “buffer zone”	3
• Request “allergen-free meal”	1
• Pre-boarding to wipe down seats and table trays	Yes 4 No 1
• Buffer zone for fragrance sensitivity	2
• Announcements to inform customers there is a peanut or tree-nut allergic passenger on board or that peanut products will not be served	Yes 4 No 7
Free snack policy on peanut/nut/sesame	
• Serving peanuts	Yes 2 No 11
• Serving nuts and sesameaw	Yes 8 No 1
• First class warmed nuts	3
Gluten-free meals	Yes 11 No 1
Lactose-free meals	1
Shellfish served	Yes 4 No 3
Fish served	Yes 6 No 1
Buffer zones for passengers allergic to pets	5

^a In general air lines cannot guarantee an entirely peanut-free environment. Modified from reference [30]

Table 5 Recommendations to prevent and manage in-flight allergic events

- Promote the prevention of allergic diseases via passenger education
- Medical consultation for high-risk passengers before traveling
- Train and re-train aircrews
- Promote general preventive measures during the flight: hydration, food allergen avoidance (especially peanuts, tree nuts, other foods, as necessary)
- Provide an appropriate place for furry pets away from subjects with pet allergy
- Provide for sufficient quantities of appropriate medications: epinephrine (adrenaline), β_2 agonists for inhalation and nebulization, oral and injectable corticosteroids and antihistamines
- Oxygen

best treatment until the plane arrives at a location where the passenger can be adequately treated.

Measures to avoid peanut and tree nut exposure for peanut and tree nut allergic individuals have resulted in lower odds of in-flight SAR from these foods (Table 3) [27, 28]. Since these measures may be difficult to implement, can cause discomfort for some passengers, and result in higher costs of travel, airlines and some travelers might be reluctant to implement them.

Airline policies on allergy

Many airline carriers have devised strategies to prevent SAR and AE during travel (Table 4). However, there are no standardized measures to do so and each carrier has its own recommendations. Retrieving first-hand information about SAR and AE is difficult [29]. A summary of proposed airline policies is presented in Table 5 [30].

Conclusions

As greater numbers of people fly, the number of AE and SAR are likely to increase during flights in the future. Therefore, passengers at risk should be aware of the necessary measures to prevent and manage these emergencies. It is also vitally important that airlines are prepared to deal with these diseases by providing the necessary strategies to decrease the incidence of SAR and AE. They also should have the necessary means to treat these reactions when and if they occur. There is a clear opportunity for airlines to work alongside allergists/immunologists to implement evidence-based recommendations to prevent allergic reactions during flight, especially SAR.

Abbreviations

AE: Asthma exacerbation; SAR: Systemic allergic reaction; WAO: World Allergy Organization

Acknowledgements

This is a product of the Anaphylaxis Committee of the World Allergy Organization. The authors thank the Board of Directors for approval and support of the paper.

Funding

Not applicable.

Availability of data and materials

Not applicable.

Authors' contributions

MSB drafted the manuscript. All authors contributed to the conception of the review and revising it critically for important intellectual content. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

Consent for publication was granted by all authors.

Ethics approval and consent to participate

Not applicable.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Author details

¹Allergy and Clinical Immunology Department, Centro Médico Docente La Trinidad, Caracas, Venezuela. ²Allergy Section, Department of Internal Medicine, Hospital Universitari Vall d'Hebron, Barcelona, Spain. ³Allergy Research Group, Institut de Recerca Vall d'Hebron, Universitat Autònoma de Barcelona, Barcelona, Spain. ⁴Allergie-Centrum-Charité, Klinik für Dermatologie, Venerologie und Allergologie, Campus Charité Mitte, Universitätsmedizin Berlin, Charitéplatz 1, 10117 Berlin, Germany. ⁵Division of Allergy and Immunology, Department of Internal Medicine, University of South Florida Morsani College of Medicine, Tampa, FL, USA. ⁶Allergy and Respiratory Research Group, Usher Institute of Population Health Sciences and Informatics, The University of Edinburgh, Edinburgh, UK. ⁷Division of Allergy-Immunology, Department of Medicine, Northwestern University Feinberg School of Medicine, Chicago, IL, USA. ⁸Department of Allergy and Immunology, Hospital Quironsalud Bizkaia, Bizkaia, Spain. ⁹Department of Allergy, Clinical Research Center for Allergy and Rheumatology, Sagami-hara National Hospital, Kanagawa, Japan. ¹⁰Pediatric Allergy & Immunology Unit, Children's Hospital, Ain Shams University, Cairo, Egypt. ¹¹Department of Pediatric Allergy & Immunology, Emory University School of Medicine, Atlanta Allergy & Asthma, Atlanta, USA. ¹²Division of Medicine, Academy of Medicine of Rio de Janeiro, Rio de Janeiro, Brazil. ¹³Division of Allergy and Clinical Immunology, Department of Medicine, Quillen College of Medicine and Center for Excellence for Inflammation, Infectious Disease and Immunity, East Tennessee State University, Johnson City, TN, USA. ¹⁴Hospital Sírio Libanês, São Paulo, Brazil. ¹⁵University Hospital of Montpellier, Montpellier, and Sorbonne Universités, Paris, France. ¹⁶Department of Rheumatology, Allergy and Immunology, Tan Tock Seng Hospital, 11 Jalan Tan Tock Seng, Singapore. ¹⁷Clinica El Avila, 6a.transversal Urb. Altamira, piso 8, consultorio 803, Caracas 1060, Venezuela.

Received: 19 December 2016 Accepted: 23 March 2017

Published online: 04 May 2017

References

1. Buehrle E, Gabler A. Notfallmedizin in flugzeug: erste hilfe über den wolken. *Dtsch Arztebl.* 2005;102:338–42.
2. Peterson DC, Martin-Gill C, Guyette FX. Outcomes of medical emergencies on commercial airline flights. *N Engl J Med.* 2013;368:2075–83.
3. Barnett J, Botting N, Gowland MH, Lucas JS. The strategies that peanut and nut-allergic consumers employ to remain safe when travelling abroad. *Clin Transl Allergy.* 2012;2:12.
4. Dowdall N. "Is there a doctor on the aircraft?" Top 10 in-flight medical emergencies. *Br Med J.* 2000;321:1336–7.
5. Comstock SS, DeMera R, Vega LC, Boren EJ, Deane S, Haapanen LA, Teuber SS. Allergic reactions to peanuts, tree nuts, and seeds aboard commercial airliners. *Ann Allergy Asthma Immunol.* 2008;101:51–6.
6. Sicherer SH, Furlong TJ, DeSimone J, Sampson HA. Self-reported allergic reactions to peanut on commercial airliners. *J Allergy Clin Immunol.* 1999; 104:186–9.

7. Sand M, Bechara F-G, Sand D, Mann B. Surgical and medical emergencies on board European aircraft: A retrospective study of 10189 cases. *Crit Care*. 2009;13:R3.
8. Nable JV, Tupe CL, Gehle BD, Brady WJ. In-flight medical emergencies during commercial travel. *N Engl J Med*. 2015;373:939–45.
9. American Medical Association Commission on Emergency Medical Services. Medical aspects of transportation aboard commercial aircraft. *J Am Med Assoc*. 1982;217:1007–11.
10. Goodwin T. In-flight medical emergencies: An overview. *Br Med J*. 2000;321:1338–41.
11. Baltsezk S. Clinic in the air? A retrospective study of medical emergency calls from a major international airline. *J Travel Med*. 2008;15:391–4.
12. Delaune EF, Lucas RH, Illig P. In-flight medical events and aircraft diversions: One airline's experience. *Aviat Space Environ Med*. 2003;74:62–8.
13. Szmajer M, Rodriguez P, Sauval P, Charetteur MP, Derossi A, Carli P. Medical Assistance during commercial airline flights: Analysis of 11 years experience of the Paris Emergency Service (SARIN) between 1989 and 1999. *Resuscitation*. 2001;50:147–51.
14. Vanden Driessche KSJ, Sow A, Van Gompel A, Vandeurzen K. Anaphylaxis in an airplane after insecticide spraying. *J Travel Med*. 2010;17:427–9.
15. Casale TB, Lemanske RF. In-flight medical emergencies. *N Engl J Med*. 2016;374:291–2.
16. Sand M, Morrosch S, Sand D, Altmeyer P, Bechara FG. Medical emergencies on board commercial airlines: Is documentation as expected? *Crit Care*. 2012;16:R42.
17. Ruskin KJ. In-flight medical emergencies: Time for a registry? *Crit Care*. 2009;13:121.
18. Federal Aviation Administration (FAA), DOT. Emergency Medical Equipment: Final rule. *Fed Regist*. 2001;66:19028–46.
19. Graf J, Stüben U, Pump S. In-flight medical emergencies. *Dtsch Arztebl Int*. 2012;109:591–602.
20. Jackson KD, Howie LD, Akinbami LJ. Trends in allergic conditions among children. United States, 1997–2011. NHCS data brief No. 121. National Center for Health Statistics: Hyattsville; 2013.
21. Ansotegui A, Sánchez-Borges M, Cardona V. Current Trends in Prevalence and Mortality of Anaphylaxis. *Curr Treat Options Allergy*. 2016 (in press).
22. Turner PJ, Gowland MH, Sharma V, Ierodiakonou D, Harper N, Garcez T, Pumphrey R, Boyle RJ. Increase in anaphylaxis-related hospitalizations but no increase in fatalities: an analysis of United Kingdom national anaphylaxis data, 1992–2012. *J Allergy Clin Immunol*. 2015;135:956–63.
23. Nocerino R, Leone L, Cosenza L, Berni Canani R. Increasing rate of hospitalizations for food-induced anaphylaxis in Italian children: An analysis of the Italian Ministry of Health database. *J Allergy Clin Immunol*. 2015;135:833–5.e3.
24. Rudders SA, Arias SA, Camargo Jr CA. Trends in hospitalizations for food-induced anaphylaxis in US children, 2000–2009. *J Allergy Clin Immunol*. 2014;134(4):960–2.e3.
25. Mullins RJ, Dear KB, Tang ML. Time trends in Australian hospital anaphylaxis admissions in 1998–1999 to 2011–2012. *J Allergy Clin Immunol*. 2015;136:367–75.
26. Greenberger PA, Lieberman P. Idiopathic anaphylaxis. *J Allergy Clin Immunol Pract*. 2014;2:243–50.
27. Boyce JA, Assa'ad A, Burks AW, Jones SM, Sampson HA, Wood RA, Plaut M, Cooper SF, Fenton MJ, Arshad SH, Bahna SL, Beck LA, Byrd-Bredbenner C, Camargo Jr CA, Eichenfield L, Furuta GT, Hanifin JM, Jones C, Kraft M, Levy BD, Lieberman P, Lucciolli S, McCall KM, Schneider LC, Simon RA, Simons FE, Teach SJ, Yawn BP, Schwanger JM. Guidelines for the diagnosis and management of food allergy in the United States: Report of NIAID-sponsored Expert Panel. *J Allergy Clin Immunol*. 2010;126:S1–S58.
28. Greenhawt M, Macgillivray F, Batty G, Said M, Weiss C. International study of risk-mitigating factors and in-flight allergic reactions to peanut and tree nut. *J Allergy Clin Immunol Pract*. 2013;1:186–94.
29. Shehata Y, Sheikh A. In-flight anaphylaxis emergencies: lessons gained from attempting a questionnaire pilot study. *Prim Care Respir J*. 2007;16:321.
30. Van Evra J, Bennet P, Wicker A. Allergic Living handy chart on the allergy policies of 13 major air carriers. *Allergic Living* magazine. Updated March 2016. <http://allergicliving.com/2010/08/30/comparing-airlines/>. Accessed 18 Dec 2016.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at
www.biomedcentral.com/submit

