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Original Research

Review of Issues and Challenges of Practicing Emergency Medicine Above 30,000-Feet Altitude: 2 Anonymized Cases



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A B S T R A C T

We present 2 anonymized cases to identify issues and challenges associated with long-haul in-flight medical emergencies. The first case involved a middle-aged man with a history of carditis on a systemic steroid who developed vomiting and rigor. Four physicians, including a pediatric intensivist, responded to the emergency call. In the second case, a pediatric trainee who was the only onboard medical personnel was summoned for help when a middle-aged man developed acute shortness of breath while traveling on a commercial flight. The cases illustrate the challenges and issues on the critical decisions of diagnosis, resuscitation, and whether the flight had to be returned or diverted. An extensive literature search is made to summarize the evidence available for these decisions and challenges. Epidemiology and outcomes associated with these medical emergencies are reviewed. In-flight medical emergencies are not rare. Physicians of all disciplines should be prepared to deal with these emergencies and make sensible decisions when equipment and resources are likely to be limited.

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Travel medicine is the branch of medicine that deals with the prevention and management of health problems of international travelers.^{1–4} Emergency medicine is occasionally practiced in the most resource-limited environment during long-haul air travel. Physicians of all specialties must be ready to offer help during air travel, which may be lifesaving.

In this review, we present 2 cases of common in-flight medical emergencies. The first case was a man with an alleged history of viral-induced carditis who became unwell while traveling on a commercial flight from Hong Kong to Vancouver; the second case involved a man with a history of anxiety who developed acute shortness of breath. Issues and challenges during the flights were discussed, and a literature review was performed.

Case Reports

Case 1

In the summer of 2016, medical help was summoned on a commercial flight approximately 2 hours after departure from Hong Kong for Vancouver. Four physicians from different nationalities attended the call, namely a pediatric intensivist, a

pediatrician, an internal medicine physician, and an orthopedic surgeon. A 66-year-old Chinese man felt unwell and vomited in his seat. He appeared to have rigors and sweating but still managed to give simple responses of yes and no. He denied chest pain and headaches. His wife was anxious but managed to give some key history that the man had a history of influenza-associated carditis and had been put on a twice daily oral steroid for a few weeks. He ate a lot of sushi before boarding and drank some red wine on board. Because the pediatric intensivist was of Chinese ethnicity and spoke the same language, he assumed a leading role in the management. The seat (the middle seat in a row of 3 seats) was dim, and examination was difficult. His heart rate was slow and occasionally irregular (range, 50s–60s). Blood pressure measured by palpation of his right radial pulse and a mercury sphygmomanometer was 110 to 120 (systolic)/60 to 70 (diastolic) mm Hg. Subsequently, a digital pulse oximeter on his finger showed a heart rate range in the 50s to 60s and oxygen saturation in the 70s to 90s. Blood glucose was checked and was within the green (normal) range. Chest auscultation and general examination revealed no sign of heart failure or aspiration pneumonitis. Pupils were equal and reactive. Mask oxygen was given at 2 L/min, but his pulse oximetry readings were around 70 to 90 while he had rigors. He vomited 2 more times and felt better. As he became more stable and without

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overt evidence of an ischemic heart attack or cerebrovascular accident, the pediatric intensivist and the other physicians agreed that the flight could be continued. The decision was considered pivotal because it affected over 300 passengers if a call for diversion was made, but the life of the patient might have been jeopardized if the flight was continued (a trip of over 10 hours). The patient was regularly reviewed on the flight, and only sips of water were allowed. The intensivist communicated with the ground-based medical assistance, completed a written report, and kept a copy of the report for himself. On landing, the patient appeared cheerful and managed to walk out without assistance by the awaiting team of paramedics. He declined to go to the emergency department in Vancouver. The presumption diagnosis was “motion sickness.”

Case 2

During a commercial long-haul flight from Milan to Hong Kong in 2014, medical help was summoned about 6 hours after departure, which was about half way into the flight. A pediatric trainee attended the call, and she was the only personnel on board. A middle-aged Italian man developed acute shortness of breath and nausea after he woke up from his sleep. He denied any chest pain, headache, or symptoms of neurologic deficits. He had a medical history of anxiety and took diazepam when required. On examination, he was pink with normal capillary refill. Although he was able to finish complete sentences, he experienced shortness of breath and his respiratory rate was elevated; his heart rate was fast and regular. He was not in any pain and did not have any physical weakness. Because he only spoke limited English, the flight attendant helped with translation. Given his medical history and background, this was likely a panic attack; hence, the pediatric trainee immediately suggested him to take the diazepam, calm down, and move to a less enclosed area. No medical equipment, such as a stethoscope, blood pressure monitor, or pulse oximeter, was available from the flight attendant. This man eventually felt better after taking the diazepam and some rest at a flight attendant resting area. His breathing rate and heart rate returned to normal after a while, and he returned to his seat. His symptoms did not recur, and he appeared well when he walked off the plane.

Discussion

These 2 cases illustrate a number of issues and challenges that a physician passenger may encounter in the thousands of commercial flights every day. These are discussed with a review of supporting literature.

How Often Do In-flight Medical Emergencies Occur and What Are the Outcomes?

Worldwide, 2.75 billion passengers fly on commercial airlines annually.⁵ Commercial aviation in-flight medical emergencies are relatively common, so it is likely that a doctor traveling frequently by air will receive a call for help at some stage in his or her career. These events are stressful, even for experienced physicians.^{6–9}

Cocks and Liew⁷ reviewed the incidence and types of in-flight medical emergencies that are likely to be encountered; the international regulations governing medical kits and drugs; and the liability, fitness, and indemnity issues facing “good Samaritan” medical volunteers. The incidence of significant in-flight medical emergencies is approximately between 1 per 10,000 and 1 per 40,000 passengers. Peterson et al⁵ described in-flight medical emergencies and the outcomes of these events. Records of in-flight medical emergency calls from 5 domestic and international airlines to a physician-directed medical communications center from January 1, 2008, through October 31, 2010, were reviewed, which represent approximately 10% of the global passenger flight volume, and medical emergencies were found to occur in 1 of every 604

flights. They characterized the most common medical problems and the type of onboard assistance rendered. The authors determined the incidence of and factors associated with unscheduled aircraft diversion, transport to a hospital, hospital admission and the incidence of death. Most in-flight medical emergencies were not serious and were related to syncope, respiratory symptoms, or gastrointestinal symptoms.⁵ A study by MedAire,¹⁰ a specialized company that provides medical advice and management to in-flight medical emergencies showed the most common in-flight medical emergencies were vasovagal episodes (22%), cardiac events (12%), gastrointestinal problems (12%), neurologic symptoms (11%), respiratory difficulties (10%), psychiatric/psychological problems (4%), and endocrine diseases (3%). Cardiac arrest is not common. Other rare in-flight medical emergencies can include injuries sustained from unexpected turbulences and items falling from an overhead luggage compartment.

Few in-flight medical emergencies resulted in diversion of aircraft or death, with about 1 death occurring per 3 to 5 million passengers. Medically related diversion of an aircraft after an in-flight medical emergency may occur in up to 7% to 13% of cases.⁷ Cardiac, neurologic, and respiratory problems made up the most serious events and accounted for the majority of the instances in which an aircraft was diverted and an unscheduled landing was necessary.¹¹ Flight diversions are very expensive, and the cost incurred is estimated to range between US \$3,000 and \$100,000 depending on the size of the plane and the cost of additional fuels and passenger rerouting.¹² Diversion is usually made after consultation with the ground-based medical service. However, the pilot in command has the authority to make the final decision for diversion. One fourth of passengers who had an in-flight medical emergency underwent additional evaluation in a hospital.⁵

Moore et al¹³ examined the incidence and character of pediatric emergencies on a US-based commercial airline over a 7-year period. There was 1 pediatric in-flight medical emergency out of every 20,775 flights. The most common in-flight pediatric emergencies involved infections (fever and otitis media), neurologic conditions (syncope and seizures), and respiratory tract problems (asthma exacerbation); the most common causes for diversions were seizures and asthma exacerbations.¹³ Pediatric in-flight fatalities are rare. Rotta et al¹⁴ reported a death rate of 0.13% for all pediatric in-flight medical emergencies, and death occurs most commonly in infants and children with a preexisting medical condition. They estimated that there are about 8 to 9 pediatric in-flight deaths occurring worldwide each year.

All these figures are probably underestimations of the actual number of in-flight medical emergencies because no mandatory reporting system exists.¹⁵ The number of in-flight medical emergencies is expected to increase as air travel becomes more accessible and affordable. The average passenger age is also steadily rising because of increased average life expectancy, and it has been estimated that by the year 2030, half of all aircraft passengers will be over 50 years of age.¹⁶ Furthermore, a new generation of aircrafts comes with larger capacities and can cover longer ranges; the Airbus A380 can carry a maximum passenger load of up to 853 passengers and can cover 15,200 km.¹⁷ Combined, these factors will further increase the probability of an in-flight medical emergency occurring during each flight.

How Likely Will Medical Help Be Available on a Commercial Flight?

In the first case, it was very fortuitous that 4 physicians from different specialties could be summoned for help, whereas in the second case, only 1 doctor was available. The latter scenario is more representative of the situation in the majority of in-flight medical emergencies.

Qureshi and Porter¹⁸ analyzed the in-flight medical emergencies occurring over a 6-month period of a single major international carrier in 2002 and reported that a request for medical assistance from a doctor, nurse, or paramedic was made in 35% of all emergencies; a doctor responded to 75% of the requests, whereas nurses and paramedics responded to 11% of cases. Medical volunteers may find assisting with an in-flight medical emergency stressful but should acknowledge that they play a vital role in successful outcomes and are not expected to work alone. Cabin crewmembers receive training in a number of emergency skills. The International Air Transport Association (IATA) recommends that all cabin crewmembers should be given initial and recurrent training in first aid and basic travel health so that they are proficient in using the first aid kit and are able to assist on-board health professionals in using the emergency medical kit.¹⁹ The US Federal Aviation Administration takes 1 step further and states that the flight attendants must receive recurrent training in the proper use of automated external defibrillators (AEDs) and perform cardiopulmonary resuscitation.²⁰

Difficulties Associated With Physical Examination

Examination of the patient may be challenging as in the case scenarios presented. Space is limited, and this often makes physical examination and medical treatment a logistical challenge. Treating the passenger in his or her seat is the safest option. The patient can be relocated to first or business class or the gallery if needed. However, treating the patient in an aisle should be avoided because this will impair the ability of the flight crew to perform their required duties.²¹ Lighting will be suboptimal, and it might be difficult to identify the patient's subtle color change (eg, cyanosis, which is a very important sign to identify). The ambient noise level is also high, making it nearly impossible to use a stethoscope or to obtain a blood pressure by merely using a sphygmomanometer and auscultation.²² Nevertheless, overt signs of cardiopulmonary failure, neurologic status, and vitals are no different from examination in normal circumstances. The 2 cases show that careful history to rule out cardiopulmonary and neurologic emergency and focused physical examination with attention to vital signs can help make accurate diagnosis and vital decisions. Both cases also illustrate that history taking is vital to medical decision making in terms of diagnosis and management. The issues about language barrier have not been documented in the literature. However, it seems that there are always medical volunteers and flight attendants who could communicate with the patient.

Onboard Equipment and Medication

In our first case, basic medical equipment, such as a sphygmomanometer, stethoscope, pulse oximeter, and blood glucose equipment, was available. There was an onboard AED, but we were unable to get an electrocardiographic machine during the moment of bradyarrhythmias. Some aircrafts may be equipped with small handheld ECG machines, which would have been beneficial in our case. In the second case, the flight crew did not offer any medical equipment for examination.

The medical manual published by the IATA includes a recommended list of medical equipment and medication that should be carried on board. It is mandated in the United States for airlines to carry AEDs.¹⁹ Supplementary oxygen for therapeutic or medical purposes can be prearranged with some of the air carriers; however, the maximum flow rate might only be limited to 4 L/min. The list of medications in the recommended emergency medical kit includes standard resuscitation medications such as epinephrine, dextrose, bronchial dilators, steroids, and anticonvulsants. Most advanced life support courses essentially teach the same principles with the acronym of ABCDs (Airway, Breathing, Circulation, and Drugs), and only a few drugs are absolutely indispensable in resuscitation.

The emergency medical equipment and medications carried on each flight might have slight variations. The requirements of the individual airlines are determined by the respective national aviation regulatory authority. The IATA does not regulate the contents of emergency medical kits of international flights.¹²

Communication With Ground

Most major airlines will have a direct link to ground-based medical assistance. Airlines might have their own ground-based physician for consultation. There are several companies (eg, MedAire) that provide 24-hour ground-to-air medical consultation and are staffed by emergency medicine physicians with additional training in aviation medicine. Most importantly, they are aware of the medical facilities in the vicinity of the aircraft should a diversion be needed.^{21,23}

There is equipment available on the market to assist telemedicine that can transmit real-time medical parameters, such as vital signs, electrocardiogram, voice and video to the ground-based medical assistance; however, these are expensive and not widely available at present.

Managing Suspected Communicable Disease

The working diagnosis of our first case is that the patient suffered from motion sickness possibly aggravated by sushi and the consumption of red wine. Gastroenteritis of viral etiology may be a differential diagnosis. It is difficult to protect passenger, crew, and even the physicians from contracting enteric pathogens (such as enterovirus, rotavirus, norovirus, salmonella, and so on). Immediate measures should include wearing a mask and observing hand hygiene principles, especially for the surrounding passengers. Public health notifications might be necessary if suspecting communicable disease. The IATA recommends that all air carriers have an emergency response plan applicable to public health emergencies.²⁴ Infectious disease accounts for about 2.8% to 4% of deaths during/from travel.^{1–4,7,25,26} In terms of morbidity, traveler's diarrhea is the most common problem encountered.^{25,26}

Medicolegal Implications

The medicolegal liability risk is extremely small, and various laws and industry indemnity practices offer additional protection to the volunteer. Although uncommon, there are documented cases of litigation against the physician who assisted during an in-flight medical emergency. In the United States, Canada, and Great Britain, physician passengers do not have a legal duty to respond to in-flight medical emergencies. In contrast, physician passengers have an obligation to respond in Australia and many European countries.²⁷ The Aviation Medical Assistance Act of 1998 states that an individual should not be liable when providing assistance in case of an in-flight medical emergency unless the individual is found to be guilty of gross negligence or willful misconduct.²⁸ For certain ground-based medical assistance and provided the communication is clear, the medical volunteer on board is relieved of liability and the ground-based medical assistance company will have insurance coverage for the liability as well as the cost of any subsequent diversion.¹⁵ Hence, some airlines have a policy to contact the ground-based medical assistance first, before asking for an onboard medical volunteer. In most cases, the airline will have a form for the volunteer medical professional to complete after assisting in the in-flight emergencies, and it is important for the involved medical professional to keep a copy. In case a formal documentation is not done by the airline, it is also recommended that the involved medical professional keep a personal documentation of the event.

Recommendations

The field of travel medicine encompasses a wide variety of disciplines including epidemiology, infectious disease, public

health, tropical medicine, high-altitude physiology, travel-related obstetrics, psychiatry, occupational medicine, military and migration medicine, and environmental health. In this day and age, international travel is made possible even for passengers who need ventilatory support. Before long-haul air travel, passengers with additional medical assistance should negotiate with the airline to detail the transport and inflight plans.^{7,29,30}

Commercial flights generally operate at altitudes between 24,000 feet (7,315 m) and 40,000 feet (12,192 m).²¹ At this altitude, passengers are exposed to reduced atmospheric pressure, a reduced oxygen level, noise, and vibration and are subject to below zero temperatures that are only a quarter inch away (the thickness of the aircraft's skin).³¹ The pressure within the cabin of most commercial airplanes is equivalent to an altitude of 8,000 feet above sea level. Most healthy passengers will be able to tolerate this environment with decreased atmospheric pressure and mild hypoxia without any adverse effect. Nevertheless, it can exacerbate certain diseases, especially cardiovascular and pulmonary conditions.

One more issue pertinent to the discussion of travel medicine is advice regarding the feasibility of long-haul travel in a patient with acute or intercurrent respiratory infection. Since the days of severe acute respiratory syndrome and recently with Middle East respiratory syndrome and severe acute respiratory infection, the role of travel in the spread and transmission of novel respiratory infections has come under intense scrutiny.^{32,33} Ideally, patients with an acute respiratory infection should not be traveling for the patient's own sake as well as for the sake of other passengers. A seemingly minor infection may predispose a major decompensation during long-haul travel in passengers with compromised respiratory health.

In-flight medical emergencies can be reduced by better preflight screening. At present, the flight carrier might only be aware of passengers with medical needs when they request for additional assistance, such as a wheelchair, in advance. There are certain medical conditions that are not conducive to air travel. The IATA has a guide to the time frame that should elapse between flying and a medical event, such as myocardial infarction or pneumothorax. Passengers with preexisting medical conditions, such as congenital cyanotic heart disease, heart failure, or chronic obstructive pulmonary disease, should be assessed by a doctor with aviation medicine experience before air travel.

If special arrangements, such as oxygen supply, ventilator support, and stretcher and seat arrangements, are necessary, passengers are also advised to contact the airline in advance and consult a physician before traveling. With advanced technology, one airline has a "patient transport compartment," which is a mobile intensive care compartment that can be installed into long-haul commercial flights for passengers requiring intensive care.³⁴

Conclusion

In-flight medical emergencies in the commercial aviation industry are relatively common, and the number is expected to increase as air travel becomes more accessible and affordable. It is very likely for a medical professional to encounter an in-flight medical emergency at some point of their career. Knowledge about the available onboard resources is very important to both the passenger and volunteer medical professional. Ideally, a mandatory reporting system should be implemented to document in-flight medical emergencies globally, so public health professionals can review the data and measures can be put in place to minimize the occurrence as well as the severity of consequences relating to in-flight medical emergencies. Physicians should be more aware about the medical conditions with which patients are at risk for flying and advise their patients accordingly. Passengers should also be more aware about the potential health issues related to flying and make preflight arrangements if necessary. Regardless of the

issues and risks discussed in this review, air travel will be an ever more important aspect of modern life and continue to bring enormous benefits to our society.

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