# In-Flight Medical Emergencies Management by Anesthetist-Intensivists and Emergency Physicians

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**BACKGROUND:** In-flight medical emergencies (IME) are challenging situations: aircraft cabins are noisy and narrow, medical supplies are scarce, and high-altitude related physiological changes may worsen chronic respiratory or cardiac conditions. The aim of this study was to assess the extent to which anesthetist-intensivists and emergency physicians are aware of IME specificities.

**METHODS:** A questionnaire containing 21 items was distributed to French anesthetist-intensivists and emergency physicians between January and May 2020 using the mailing list of the French Society of Anesthesia and Intensive Care Medicine and the French Society of Emergency Medicine. The following topics were evaluated: high-altitude related physiological changes, medical and human resources available inside commercial aircraft, common medical incidents likely to happen on board, and previous personal experiences.

**RESULTS:** The questionnaire was completed by 1064 physicians. The items corresponding to alterations in the arterial oxygen saturation, respiratory rate, and heart rate at cruising altitude were answered correctly by less than half of the participants (respectively, 3%, 42%, and 44% of the participants). Most responders (83%) were interested in a complementary training on IME management.

**DISCUSSION:** The present study illustrates the poor knowledge in the medical community of the physiological changes induced by altitude and their consequences. In addition to offering specific theoretical courses to the medical community, placing sheets in commercial aircraft summarizing the optimal management of the main emergencies likely to happen on board might be an interesting tool.

**KEYWORDS:** in-flight medical emergency, aviation, cardiac arrest, training, extreme environments, high altitude physiology.

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Commercial air flight is becoming the most popular means of human transportation worldwide. About four and a half billion people traveled by plane in 2019 according to the International Civil Aviation Organization. As a result of the global aging of the population, in-flight medical emergencies (IME) are expected to increase as well.[7] Previous studies reported the IME incidence is 1 per 10,000 to 40,000 passengers traveling each year and, in 50–75% of the cases, a physician is present onboard.[4,5,7]

Managing an IME is challenging for any clinician, especially for those who have had no specific training in emergency medicine.[4] Aircraft cabins are narrow, noisy, and low-resource environments. Patient examination may also be complicated by a language barrier.[5] Available medical supplies are limited and depend on airline companies.[7] Moreover, high altitude exposes passengers to hypobaric hypoxia, and thus a drop in arterial oxygen partial pressure ($P_aO_2$), potentially leading to the worsening of pre-existing medical conditions such as chronic obstructive pulmonary disease (COPD) or chronic heart failure.[1] It would, therefore, be helpful for any physician to understand the physiological changes induced by altitude, be

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aware of the main IME encountered during a commercial flight, and also which medical and human resources are available on board to deal with those. Because of their specific training, anesthetist-intensivists and emergency physicians should be expected to appropriately manage such emergencies. The aim of the present study was to evaluate their current knowledge in the following aspects of IME: high-altitude related physiological changes, medical and human resources available inside commercial aircraft, and knowledge of the most common medical incidents likely to happen on board. Previous personal experiences were also investigated.

## METHODS

### Subjects

We conducted a French prospective observational study from January to May 2020 among French anesthetist-intensivists and emergency physicians (residents and attendings). The primary outcome was the descriptive analysis of the results from a 21-item questionnaire. The answers were provided anonymously. No personal information was recorded. The study obtained a favorable decision from the French Society of Anesthesia and Critical Care Medicine [Société Française d'Anesthésie Réanimation (SFAR)] ethics committee (registration number IRB 00,010,254-2020-003).

### Survey

The following topics were evaluated: 1) air flight physiological changes; 2) medical and human resources available onboard; 3) practical considerations: common medical incidents likely to occur on board; and 4) personal experiences. An e-mail including the rationale of the present study and a link to the survey was sent to the members of the French Society of Anesthesia and Critical Care Medicine (SFAR) and the French Society of Emergency Medicine [Société Française de Médecine d'Urgence (SFMU)]. The survey was edited by SFAR through the website SurveyMonkey© (www.surveymonkey.com). The study lasted 5 mo (from January 1st to May 31st, 2020). Every questionnaire fully completed during this period was included and analyzed. Those that were either incomplete or received too late were not considered.

### Statistical Analysis

We provide a strict report of the answers to our questionnaire. Results are reported as absolute values and percentage. Statistical analysis was performed using Microsoft Excel© (Microsoft Office 2021©).

## RESULTS

A total of 1064 physicians completed the survey: 882 (83%) anesthetists and 182 (17%) emergency physicians; 857 (81%) attendings and 207 (19%) residents (**Table I**). The items corresponding to alterations in arterial oxygen saturation, respiratory rate, and heart rate at cruising altitude were answered correctly by less than half of the participants (respectively, 3%, 42%, and 44% of the responders). Of the participants, 141 (13%) and 184 (17%) were aware that the presence of an automated external defibrillator (AED) on board is not mandatory and that oxygen flow is limited.

Among the participants, 559 (53%) had an accurate knowledge of the most common medical incidents likely to happen on board (**Table II**). There were 476 participants (44.7%) who had already attended during an IME. Among those, 245 (51%) were not confident during their intervention. Finally, 881 responders (83%) were interested in attending a specific training on IME management.

## DISCUSSION

Our results emphasize several points. First, basic physiological changes induced by altitude, such as hypoxia or alterations

**Table I.** Physiological Changes Induced by High Altitude and Medical/Human Resources Available on Board.

| QUESTIONS | CORRECT ANSWER | NUMBER OF CORRECT ANSWERS *N* (%) |
|---|---|---|
| With altitude, partial pressure of arterial oxygen | Decreases | 1012 (95%) |
| The pressure in the aircraft cabin at cruising altitude | Is equivalent to the pressure at an altitude of 6562–8202 ft (2000–2500 m) | 583 (55%) |
| The volume of gas in a closed cavity | Increases when atmospheric pressure decreases | 806 (76%) |
| At cruising altitude, arterial oxygen saturation at rest | Ranges between 88 to 92% | 32 (3%) |
| At cruising altitude, minute ventilation at rest | Is higher than at sea level | 444 (42%) |
| At cruising altitude, heart rate at rest | Is higher than at sea level | 473 (44%) |
| Onboard, the hydration state | Dehydration is higher than at sea level | 904 (85%) |
| Medical/human resources available onboard | | |
| Cabin crew is systematically trained to cardiopulmonary resuscitation | Yes | 1016 (95%) |
| Legally, all airline companies have to be equipped with an automated external defibrillator | No | 141 (13%) |
| Administration of high flow oxygen (flow > 5 $L \cdot min^{-1}$) is possible onboard | No | 184 (17%) |
| Aircraft captain authorization is necessary to open the medical kit | Yes | 660 (62%) |

**Table II.** Practical Considerations and Previous Personal Experiences.

| QUESTIONS | CORRECT ANSWER | NUMBER OF CORRECT ANSWERS N (%) |
|---|---|---|
| Preflight medical examination is mandatory for patients with chronic medical conditions | No | 953 (90%) |
| In the following list, which emergency is the most often encountered onboard | Syncope | 559 (53%) |
| A ground medical assistant is available 24 h per day | Yes | 753 (71%) |
| In the event of a cardiac arrest, the decision to divert a flight must be taken | After ROSC* | 262 (25%) |
| In case of an emergency the decision to divert a flight is taken by | The aircraft captain | 842 (79%) |
| | **YES** | **NO** |
| Previous personal experiences | | |
| Have you ever assisted with an IME** (*N* = 1064)? | 476 (45%) | 588 (55%) |
| Did you feel confident during your intervention (*N* = 476)? | 245 (51%) | 235 (49%) |
| Do you think that a complementary training about IME** management would be useful (*N* = 1064)? | 881 (83%) | 181 (17%) |

*Return to spontaneous circulation; **in-flight medical emergency.

in respiratory and heart rates, are ignored by many physicians. Secondly, there is a misconception regarding available medical resources on board. Finally, the majority of the responders are interested in a complementary course regarding this specific topic.

Commercial aircraft cabins cruise at an altitude comprised between approximately 32,808 to 45,932 ft (10,000 to 14,000 m) above sea level. Compared to the values measured on the ground, the atmospheric pressure at such altitudes is diminished, resulting in a lower oxygen partial pressure. In order to mitigate the hypoxia resulting from exposure to this environment, airplane cabins are pressurized to reproduce the atmospheric pressure recorded at an altitude of 6562–8202 ft (2000–2500 m). Although effective, this countermeasure fails to completely prevent the occurrence of a relative hypoxia and mean arterial oxygen saturation often ranges between 88% and 92%.[1] While a healthy patient can easily tolerate such $S_pO_2$ levels, those suffering from chronic medical conditions may not.[3] Relative hypoxia induces compensatory hyperventilation, tachycardia, and an increased hypoxic pulmonary vasoconstriction; the increased cardiac output, resulting from the tachycardia, limits the diffusion of oxygen from the alveoli to the arteriolar blood and, therefore, worsens the hypoxemia. All these phenomena are potentially harmful for COPD patients or those suffering from chronic heart failure.[1,3]

According to the Boyle-Marriot law, a decrease in the atmospheric pressure induces an increase in the volume of gases present in closed cavities, such as the sinuses, intestines, and lungs. It may be responsible for specific benign symptoms such as abdominal, ear, or sinus pain.

The most frequently reported emergency is syncope, which is relatively easy to diagnose and manage.[5,7] Fortunately rare (0.3% of all IME), in-flight cardiac arrest remains one of the most dreaded events by physicians. A previous work reports a total survival rate of 14% among 40 patients experiencing in-flight cardiac arrest.[2] Among those presenting with a shockable ventricular fibrillation or ventricular tachycardia, survival increased to 50%. In contrast, none survived with asystole as the initial rhythm.[2] Few recommendations regarding in-flight cardiac arrest management have been published and some specificities must be considered: high altitude exposure leads to a decreased stroke volume, therefore, intravenous fluid expansion should be promptly considered; and high altitude rapidly increases blood epinephrine level, thus, epinephrine injection may be less efficient.[3,4,6]

The decision to divert a flight is under the sole responsibility of the aircraft commander. It implies additional risks for both crew and passengers, due to an unplanned landing in potentially degraded conditions (overweighted plane and/or poor weather conditions).[4] Moreover, a previous study reported that in the event of an in-flight cardiac arrest with a nonshockable rhythm, the mortality rate was 100%. Diverting a plane for those cardiac arrests might not be appropriate.[2] It seems more reasonable to recommend plane diversion in the event of a cardiac arrest with a shockable rhythm or once the patient resumes a spontaneous cardiac rhythm.[4,6]

Obviously, every situation is unique and should be analyzed as such. On-ground medical assistance is constantly available and may help to make such a decision. An AED is standard and essential equipment to improve survival in case of a cardiac arrest with a shockable rhythm.[2,6] Yet it is not mandatory to have one aboard all commercial aircraft. The U.S. Federal Aviation Administration requires that all planes traveling to or from the United States carry an AED on board, while the European Union Aviation Safety Agency (EASA) does not.[4] EASA recommends carrying an AED according to risk assessment procedures, at the discretion of the operator in charge (number of passengers, flight duration). Fortunately, most of the airlines provide an AED on board.

Respiratory symptoms are the second cause of IME. Hypoxia may exacerbate chronic cardiorespiratory conditions such as asthma, COPD, or chronic heart failure.[1] Preflight medical consultation is not mandatory before flight. However, patients with severe conditions and/or with home oxygen therapy might benefit from a medical examination before boarding an airplane.[1] If necessary, companies may provide supplemental oxygen on demand. Physicians must be aware that in a commercial aircraft, oxygen delivery systems are usually limited to a maximum flow of $4\ L \cdot min^{-1}$.[1]

Our study obviously suffers from certain limitations. Any physician, regardless of medical training, can be confronted with an IME; therefore, it could have been interesting to target the whole medical community. We focused on anesthetist-intensivists and emergency physicians because, among all, they are the most trained to adequately face a medical emergency. Even in this highly trained population, we underline the lack of knowledge regarding high altitude physiological changes and the available resources on board.

Our survey highlights that about half of the participants experienced an IME and, among those, half were not confident during their intervention. Moreover, the majority of the participants considered that a complementary training would be beneficial in order to improve IME management.

In conclusion, IME are expected to increase over the years and remain challenging situations for physicians. A complementary training, at least theoretical, seems necessary to improve IME management. For example, didactic online training courses could be offered. Another interesting tool could be to provide simple and clear sheets aboard airplanes summarizing the main physiological changes induced by altitude and the optimal management of the most common emergencies.

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