

In-Flight Medical Events and Cabin Crew First Aid Response

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- INTRODUCTION:** In-flight medical events (IMEs), although rare, are challenging due to the limited onboard resources and the time needed to reach an airport. Cabin crewmembers (CCMs) are trained to provide first aid, but their effectiveness has not been appropriately studied.
- METHODS:** IMEs occurring in the biggest airline of Greece were prospectively recorded during a 5-yr period (2014–2018) and categorized according to a symptom-based taxonomy.
- RESULTS:** During the study period 990 IMEs were recorded corresponding to 16 IMEs for each million passengers or 1.8 IMEs for every thousand flights. The most frequent events were loss of consciousness (38.4%) followed by injuries (8.6%), gastrointestinal problems (8.3%), respiratory symptoms (7.3%), anxiety (5.7%), and burns (5.9%). Diversion was decided in 3% of the cases while death on board was rare (0.3% of events). CCMs responded in 33.5% of IMEs without assistance by a volunteer health professional, achieving a 97% success rate.
- DISCUSSION:** IMEs are rare events and the majority can be treated with simple first aid measures. CCMs acting according to a simplified algorithm were very efficient in providing first aid. A standardized symptom-based IME form will assist in creating a reliable registry for further studies.
- KEYWORDS:** in-flight medical event, first aid, cabin crewmember.

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Commercial air traffic has dramatically increased over the last decade, with over 2.75 billion passengers flying each year.¹⁰ In-flight medical events (IMEs) pose a unique challenge due to the limited medical resources on board and the time required to land for appropriate care.^{4,5,12} In order to look after these events, cabin crewmembers (CCMs) receive initial and recurrent first aid training as part of their certification. Health care professionals on board are also called by CCMs to volunteer their assistance and several legislative actions have been taken to facilitate their involvement.¹ The rarity of the events, the diversity of care provider reports, and the difficulty in obtaining valid outcome data make the study of these events difficult.^{11,19,20}

Aegean Airlines is the flag carrier of Greece operating from hubs in Greece (Athens and Thessaloniki) and Cyprus (Larnaca) to several Greek, European, and Middle Eastern destinations. The airline is a member of Star Alliance and operates a fleet of 53 Airbus aircraft (A319, A320, and A321) carrying over 14 million passengers each year.

Aegean CCMs receive initial and recurrent first aid training according to the European and International Resuscitation Guidelines^{21,27} and the European Commission Regulations,⁷ with a special emphasis on life-critical events such as loss of consciousness, cardiac arrest, and choking. First aid training since 2008 is provided to all Aegean CCMs based on a simplified action algorithm according to the affected person's symptoms. The algorithm guides CCMs to take immediate action on life-threatening and time-critical events such as pulseless collapse and upper airway obstruction without waiting for the arrival of a volunteer health care professional (**Fig. 1**). In all

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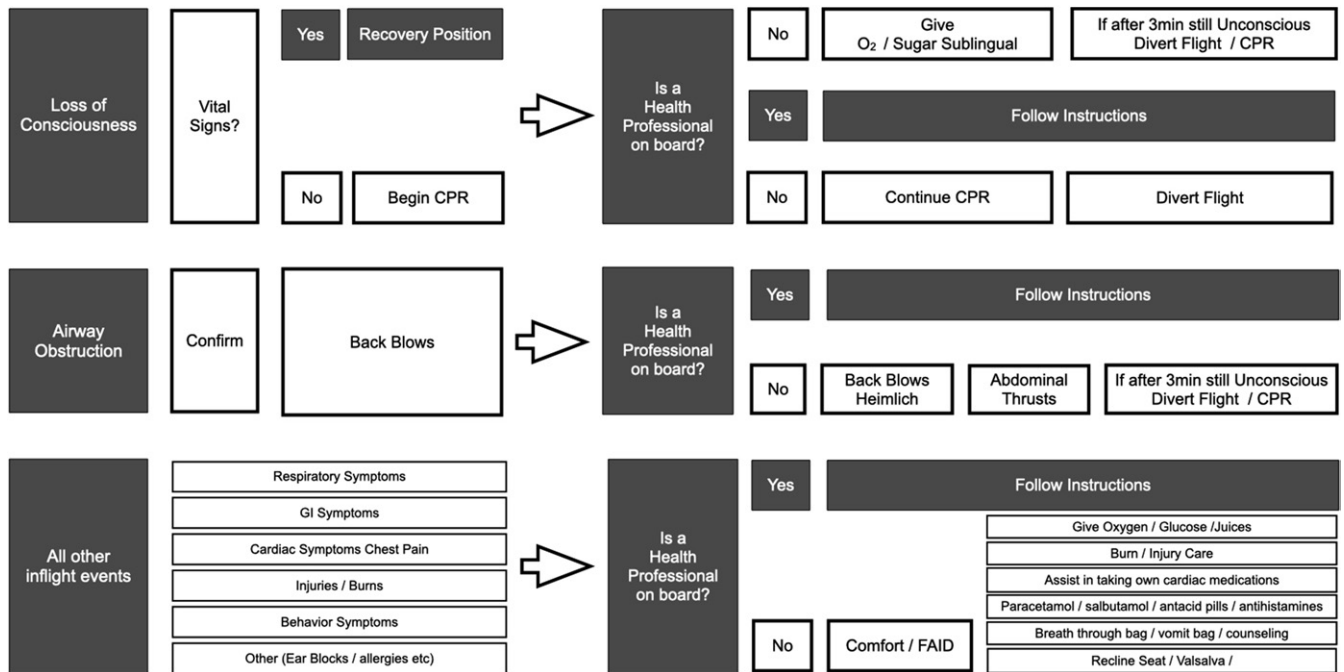


Fig. 1. In-flight medical events action algorithm used by Aegean cabin crew. The algorithm requires immediate response to life threatening events (loss of consciousness and choking). All other events are treated in the absence of a health care professional with simple measures based on symptomatology.

other (not time critical) events, CCMs initiate appropriate first aid or comfort measures while the assistance of a health care professional on board is requested. After each IME the CCM or the volunteer health professional fill out an electronic form with passenger details, estimated diagnosis, and first aid provided. CCMs are instructed to report only symptoms and avoid the use of clinical terms and medical diagnoses. The form is dispatched to airline flight operations and an anonymized copy devoid of any passenger or crew personal details is shared to the authors for feedback.

Despite the fact that IMEs are frequently treated in most airlines by CCMs, the available literature focuses mainly on the actions of volunteer physicians, with very few studies examining the effectiveness of cabin attendants to provide first aid.^{9,10,14} The aim of this study was to examine the effectiveness of cabin attendants in providing first aid based on a simple action plan and contributed data from a south European airline.

METHODS

Collection of in-flight medical event reports started in 2012 but CCMs' first aid training and IME reporting was standardized after 2013. We prospectively selected data during a 5-yr period from 2014 to 2018. During that period Aegean Airlines had expanded with increased passenger volume making any findings more statistically meaningful. The reports were regularly reviewed by the authors and all IMEs classified in consensus based on a symptoms taxonomy based on the one proposed by Mahony *et al.*¹⁰:

1. Loss of consciousness
2. Respiratory/difficulty breathing
3. Cardiac symptoms/chest pain
4. Gastrointestinal symptoms
5. Pain
6. Allergic reaction
7. Infectious disease/fever
8. Injury
9. Burn
10. Behavior events
11. Bleeding, no injury
12. Obstetrical symptoms/delivery
13. Other

IME reports filed by CCMs had symptom-based descriptions while health care professionals tended to record the event using clinical terms. Whenever a clinical diagnosis was recorded by a health care professional or one such was obvious from the CCM report, then we classified the event in consensus under a clinical subcategory. Passenger gender and age, phase of flight, date, destination, flight time, and any previous assistance or medical history was recorded. Additionally, we noted the type of onboard assistance (flight crew, doctor, nurse, etc.), the medical supply that was used, and the outcome of the emergency, including diversions and need for an ambulance at the destination airport. We specifically looked at the outcome of the events in relation to the providers of first aid. Data were analyzed using descriptive statistics and dichotomous variables were tested for association using the Chi-squared test for independence with Yates continuity correction. A value of $P < 0.05$ was used to indicate statistical significance. Statistical analysis was performed

using the JASP 0.13.1 software. The study protocol was approved by the Research and Ethics Committee of the Hellenic Air Force Academy and use of data was authorized by the management of the participating airline.

RESULTS

During the 5-yr period 2014 to 2018 a total of 990 IMEs were recorded. During the same time Aegean had carried over 61 million passengers with over 540,000 flights. This corresponds to 16 IMEs for each million passengers or 1.8 IMEs for every thousand flights (**Table I**). There was no difference for frequency of IMEs between weekdays ($P = 0.227$). A little over half of the events ($N = 539$; 54.5%) happened during daytime. Daytime IMEs were twice as likely to have a worse outcome (7%) compared to nighttime IMEs (4%), although this difference was not statistically significant ($P = 0.235$). Most IMEs occurred in flights that departed from Athens (30.1%) and Thessaloniki (12.3%)—the main hubs of Aegean Airlines. The majority of the events involved adults with a mean age of 41 yr (91.4%) while adolescents (2.2%) and children (6.3%) were rarely involved. There was no difference in the final outcome (better-worse) between various age groups ($P = 0.653$).

There were more IMEs involving female (51.6%) than male (42.2%) passengers, while in a number of events (6.2%) it was not possible to determine gender due to lack of proper recording and the anonymity of reports. There was no difference in the outcome of first aid between the genders ($P = 0.078$). Nationality was not recorded in 74.4% of the cases and the authors had no way to determine it due to the anonymity of the reports. Seat occupancy was not recorded in 63.3% of the cases. In the recorded cases there was no statistical difference in the frequency of IMEs between window, aisle, or middle seats ($P = 0.219$). The majority of the affected passengers (94.6%) had not declared any special need while 23 out of 990 IMEs (2%) had boarded the aircraft on a wheelchair. Only three IMEs involved unaccompanied minors. Passengers who boarded the aircraft on a wheelchair were three times more likely to have worse outcomes (18%) than the rest of the passengers (6%), a statistically significant difference ($P = 0.003$). Most IMEs occurred during the cruise phase of the flight (78%), with smaller numbers occurring during boarding (7.2%) and disembarking (4.7%).

In this study the most frequent IMEs according to our symptom-based taxonomy (**Table II**) were loss of consciousness (38.4%; mainly presyncope and syncope) followed by seizures (8%) and hypoglycemia (5%). Injuries were second in frequency

(8.6%), followed by gastrointestinal problems (8.3%), respiratory symptoms (7.3%), anxiety (5.7%), and burns (5.9%) (**Table II**). Most of the passengers denied any past history (60.5%) while the rest reported a variety of pathologies, including cardiovascular diseases (7.9%), anxiety disorders (3%), and gastrointestinal problems (2.8%). There was no significant difference in the outcome based on passenger medical history ($P = 0.928$). Pain symptoms were also rare (5%), with headache being the most common (60%) and successfully managed with paracetamol.

A great majority of IMEs (30.8%) resolved with simple comfort actions such as offering water or juice, opening overhead vents, and reclining the seat. In a fifth of all IMEs (20%), the passengers had to be reclined in the recovery position. Oxygen was administered in 7.5% of the events. Glucose sublingual or juice was given in 6.5% of the IMEs. The crew requested assistance in 71% of the events and a health care professional (63% a physician) was available in 67.5% of the cases. The first aid kit was opened in 18% of the IMEs but was finally used only in 15% of all cases. The most frequently offered medications were paracetamol tablets (3.6%) and a hydrogel for burns (4.7%). The medical device frequently requested by health professionals was the manometer, although it was rarely used (1%).

Diversion was decided in 3.2% of the cases. Diversion was more frequent if the IME involved a passenger who boarded the plane on a wheelchair ($P = 0.016$). During this 5-yr period we had only 3 deaths on board (0.3% of events) out of 61,283,428 passengers carried on 541,032 flights (1 death on board per 20.5 million passengers or 180,000 flights).

CCMs provided assistance in the absence of a health professional in 33.5% of these 990 in-flight events, achieving a 95% success rate (stable or improved health condition). This compares favorably with the 92% success rate when first aid was provided by health care professionals. The difference in first aid outcome was in favor of CCMs ($P = 0.036$) (**Table III**). CCMs decided for diversion in 6 out of the 332 cases (2%) they had to treat alone, compared to 25 diversions out of 668 IMEs (3%) treated by health care professionals. This difference was not statistically significant ($P = 0.112$).

DISCUSSION

In this cohort we noticed 16 IMEs per million passengers or 1.8 events per a thousand flights in an airline that operates short and medium distance routes (up to 4 h). These numbers are at the low end of 5 to 159 incidents per million passengers

Table I. Aegean In-Flight Medical Events (IMEs) Per Year, Number of Passengers, and Flights Performed.

YEAR	IMEs	PASSENGERS	IMEs PER PASSENGER	FLIGHTS	IMEs PER FLIGHT
2014	159	9976,885	0.000016	96,330	0.0017
2015	325	11,657,810	0.000028	110,830	0.0029
2016	231	12,466,367	0.000019	113,490	0.0020
2017	154	13,216,828	0.000012	109,810	0.0014
2018	121	13,965,538	0.000009	110,580	0.0011
Total	990	61,283,428	0.000016	541,030	0.0018

Table II. Aegean Airlines In-Flight Medical Events and Final Outcomes According to Various Clinical Conditions.

GROUP DIAGNOSIS	SPECIFIC DIAGNOSIS	OUTCOME		
		IMPROVED	WORSE	TOTAL
Loss of consciousness (LOC)	Total LOC events	355	28	381
	Syncope	209	12	224
	Presyncope	91	4	95
	Hypoglycemia	20	1	21
	Seizures	27	5	32
	Stroke probable	5	1	6
Respiratory/difficulty breathing	Death	3	3	3
	Total respiratory events	65	8	73
	Dyspnea	62	8	70
	Respiratory symptoms	1	0	1
	Airway obstruction	2	0	2
Cardiac symptoms/chest pain	Total cardiac events	38	4	42
	Tachycardia	3	0	3
	Arrhythmia	1	0	1
	Chest pain	27	4	31
	Hypertension	4	0	4
Gastrointestinal (GI) symptoms	Hypotension	3	0	3
	Total GI events	78	5	83
	Abdominal pain	30	2	32
	Vomiting	32	3	35
	Nausea	16	0	16
Pain	Total pain events	50	3	53
	Pain arm	3	0	3
	Pain back	1	1	2
	Pain leg	6	1	7
	Headache	32	1	33
	Sinus block	8	0	8
Allergic reaction	Total allergic events	28	0	28
Infectious disease/fever	Total infectious events	34	4	38
	Fever	9	0	9
Injury	Infectious disease	25	4	29
	Total injury events	80	6	86
	Injury, head	28	2	30
	Injury, laceration	21	1	22
	Injury, arm	5	2	7
	Injury, leg	16	1	17
	Injury, not otherwise specified	4	0	4
	Insect bite	6	0	6
Burn	Total burn events	57	2	59
	Burn, other	8	0	8
	Burn, abdomen	8	1	9
	Burn, arm	2	1	3
	Burn, chest	2	0	2
	Burn, face	3	0	3
	Burn, hand	8	0	8
	Burn, leg	26	0	26
Behavior	Total behavior events	119	5	124
	Discomfort	22	1	23
	Dizziness	34	0	34
	Drowsiness	3	0	3
	Anxiety	22	1	23
	Alcohol intoxication	3	0	3
	Neurological symptoms	4	0	4
	Panic attack	31	3	34
Bleeding no injury	Total bleeding - no injury	13	3	16
	Bleeding, other	2	1	3
	Bleeding, ear	2	0	2
	Bleeding, face	2	0	2
	Bleeding, nose	7	2	9
Obstetrical symptoms/delivery	Total obstetrical events	3	1	4
Other	Total other	3	0	3
Total in-flight events		925	65	990

In cases where a clinical condition or diagnosis could be grouped under a symptom category then the individual statistics are presented under the total of the group.

reported by other authors.^{11,12,16}

We consider our findings to be representative of the actual occurrence since CCMs are obliged by Aegean operational procedures to report all in-flight events. The low incidence can probably be attributed to the short and medium duration flights of Aegean Airlines and the probable underreporting of common minor events such as ear blocks and mild passenger anxiety.

The IMEs encountered by order of frequency were loss of consciousness followed by injuries, gastrointestinal problems, and respiratory symptoms (Table II). Our findings are in accordance with other publications^{6,8,23} and the aggregated frequencies of 14 studies with 49,100 IMEs¹¹ where syncope or presyncope was the most common event (32.7%), followed by gastrointestinal (14.8%) and respiratory (10.1%) symptoms.

Loss of consciousness (LOC) in our series was mainly the result of syncope and presyncope (Table II). Syncope is defined as a transient loss of consciousness and postural tone. When recovery occurs prior to complete loss of consciousness, the episode is referred to as presyncope.² Aegean CCMs have been instructed since 2010 to respond in a syncopic event by putting the breathing but unresponsive passenger in the recovery position after we noticed that CCMs had difficulty properly performing jaw thrust or chin lift. The recovery position is also advised both by international consensus guidelines and the European Resuscitation Council since 2015.^{21,27} If loss of consciousness persists, they are advised to administer sublingual glucose tablets or sugar in order to address a

Table III. Aggregated Outcomes of In-Flight Events as Recorded at the End of the Flight.

OUTCOME	CABIN CREW	HEALTH PROFESSIONAL	TOTAL
Better	309*	616	925
Worse	13	52	65
Total	322	668	990

* Cabin crews had better outcomes than health professionals: $P = 0.036$.

possible hypoglycemic event.²¹ If the passenger continues to be unresponsive after 3 min the crew diverts the flight to the nearest suitable airport (Fig. 1). In the absence of vital signs they are instructed to immediately start CPR. CCMs in this series provided first aid without the presence of a health professional, achieving a 97% recovery rate, which is better than that reported in the literature (85.1%),⁹ reflecting a safe management of LOC events.

The incidence of seizures was low (3%) compared to the reported average (5%)¹¹ and resolved spontaneously in 84% of cases. In five cases the seizures were prolonged or recurring and an ambulance was called upon arrival without diversion from the planned flight route. Although hypoglycemia is a known cause for loss of consciousness events it was a small part of all LOC events in our series (5%).

Gastrointestinal problems in our series were second in frequency (8.3%) but still fewer compared to the average percentage of 14.8% in a review of 14 studies.¹¹ This difference may be explained by the fact that many of these studies reported on long-haul flight events. It is possible that the prolonged exposure to cabin altitudes between 6000 to 8000 ft (1829 to 2438 m) may have provoked trapped gas type abdominal discomfort. Aegean Airlines serves mainly Mediterranean food on board that is more easily digested compared to the spicy meals considered by some authors as a reason for abdominal discomfort in flight.⁹

Injuries were the third most common event over these 5 yr (8.0%) and this frequency is relatively higher than the reported average of 5%.^{11,26} The usual type was a blunt head injury from a falling object from the overhead lockers (38%), a mechanism also reported by other authors.^{11,14} We have noticed a sharp increase in these events between 2014 and 2016 (average 25% each year), possibly as a result of more passengers traveling on discounted tickets with overstuffed carry-on bags. After CCMs were briefed on this finding and instructed to enforce an orderly passenger disembarking, we noticed a 50% drop in injuries since 2016.

Respiratory problems were the fourth most common problem (7.3%), but again this frequency was lower than the average reported in the literature (10.1%).^{11,14,26} This finding most probably reflects the low prevalence of asthma in the Greek population (6.6%), compared to over 15% among north Europeans.²⁵ The most common presenting symptom was dyspnea (95%). CCMs had to provide first aid according to European Resuscitation Council guidelines,^{21,27} with 84% of passengers improving after oxygen or salbutamol administration. This compares favorably with the 91% rate of improvement achieved by volunteer health professionals in this study.

The prevalence of burns during the study period of 5.9% is comparable to 5.6% reported by some authors⁹ and slightly higher than other studies (1.4–1.8%).^{14,17} In our series burns mostly occurred in children (76%) as a result of accidental spill of hot beverages by other passengers. In a study of IMEs involving only children, burns represented 21% of a total of 11,719 calls to a very busy ground-based remote medical call center.¹⁸ After noticing this trend in mid-2015, CCMs were instructed to ensure safe handling of hot beverages by passengers. This resulted in a statistically significant decline of burns from 1.7 per million passengers before 2016 to 0.6 per million passengers in 2017 and 0.2 per million passengers in 2018 ($P = 0.016$). Most of these injuries were minor first degree burns successfully treated with hydrogel. Only two cases required further treatment in a medical center, one involving a CCM injured while manipulating hot meals in the aircraft oven.

The rate of all cardiac events (4%) was lower than the reported average (7%),^{11,16,23} a finding probably related to the relatively short duration of flights. Chest pain was very rare (3%) and most of these events were treated by physicians on board (80%). Physicians have a reported in-flight diagnostic accuracy of about 79% for cardiac events⁴ and in our series 88% of the passengers with cardiac symptoms improved before landing. Several studies have shown a nearly double rate of survival if a bystander initiates CPR instead of waiting for the arrival of a health care provider.^{3,22} CCMs responding alone to the call of a passenger with chest pain are instructed to use simple first aid measures such as lowering the seat, providing high flow oxygen, and assisting the affected passenger in taking his own medications. Diversion for chest pain was necessary in only two cases—both decided by a health professional. During this 5-yr period we had only three deaths on board (0.3% of events) in agreement with the estimated mortality rate of 0.3% of in-flight medical emergencies.^{8,11,24}

Severe anxiety (5.7%) presented in the form of an established panic attack with hyperventilation. Although the average reported incidence of psychiatric emergencies in the literature is lower (3%),¹¹ we consider this number to be an underestimation as suggested by the 8% incidence reported by other authors.²⁶ It is probable that anxiety is widely considered by CCMs as a common passenger behavior not worth recording as only 2 out of 25 records related to anxiety disorders in our study were made by flight attendants.

Ear block is very common among passengers that usually resolves spontaneously with simple measures such as Valsalva maneuver or jaw movements. Ear blocks are rarely recorded by CCMs as they are considered a common nuisance of the flight and the symptoms are usually well tolerated by the passengers. Sinus barotrauma (barosinusitis or sinus block), however, is a much more painful event and the affected passengers are forced to request assistance when surprised by the intensity of pain. Fortunately, sinus barotrauma was not very common in our series (0.8%).

Diversion was decided in 3% of the total events. This number is below the reported 3.8% diversion rate in one study where

CCMs had to decide¹⁶ and the average rate of 4.4% from 14 studies with 56,599 IMEs.¹¹ Although the odds for diversion normally decrease with long-haul flights over 10,000 km,¹⁶ diversion was probably deferred in this series due to the short time to reach the final destination. The main cause (35%) for diversion was a prolonged loss of consciousness. CCMs decided for diversion in 2% of the cases—a percentage close to the 3% of health care professionals of our study. This difference was not statistically significant ($P = 0.163$).

Most of the literature on IMEs focuses on health professionals who volunteer their services onboard an aircraft.^{8,11,12} Very few studies have focused on the actions performed by cabin crews^{9,10} despite the fact that they have to manage a significant percentage of in-flight emergencies alone. In this prospective 5-yr study, CCMs responded in the absence of a health professional in 33.5% of 990 in-flight events following a simplified symptom-based algorithm. The ability of physicians to efficiently handle in-flight emergencies is also not well known. In one study only 1 in 10 primary care doctors felt confident managing in-flight medical emergencies;¹⁵ physician-targeted checklists such as mobile phone applications may have prompted some actions, but delayed others.¹³

CCM reports can provide important data regarding IMEs, however, like many other authors, we have noticed a significant variability in form and terminology in the reports.^{10,19,20} A standardized report form based on symptoms rather than clinical diagnoses will contribute to improved data collection and better CCM first aid training. Although this may prove be a costly and difficult task,²⁴ the familiarity of CCMs with in-flight emergencies and their ability for time-critical decisions demands further investigation of their role in providing first aid on board.

This study contributes data to the limited literature on cabin crew effectiveness to provide first aid in the absence of a health care professional. A strength of this study is that all events were prospectively collected and studied by the same group of physicians that provided the first aid courses to Aegean CCMs. This allowed ample feedback on the efficiency of the proposed symptom-based algorithm for first aid and consensus classification of the reported events. Limitations of the study include the frequent use of free text to report IMEs by CCMs, allowing ambiguity in interpretation, the relatively small number of events, and the possible bias related to the fact that the authors were also the first aid instructors. Our data are also only relevant to short and medium range flights.

Medical events on board Aegean Airline flights occur with the same frequency reported in the literature. The vast majority of these events recover with simple care before landing. Cabin crews are important for aviation and passenger safety and, given appropriate instruction, they can provide equally efficient first aid in flight in the absence of a health professional. A standardized in-flight medical event form based on symptoms will improve data collection and level of care in flight.

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