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ORIGINAL RESEARCH

Epidemiology and clinical outcomes of emergency medical events at an international airport

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Abstract

The use of airplanes is becoming increasingly frequent worldwide. However, although the number of flight passengers is steadily increasing, there is no comprehensive database that accurately reflects the frequency of emergency medical events that occur in airports. We evaluated the characteristics and treatment outcomes of patients who had emergency medical events at an airport. We retrospectively reviewed cases of patients who had emergency medical events at International Airport between May 2013 and April 2018. A comparative analysis was conducted on gender, age, disease, temperament, and average length of stay between patients visiting the airport and the general population visiting the emergency room (ED). Among the 258,823 patients who visited our ED during the study period. A total of 846 patients (0.3%) were transferred from the airport; the proportion of men was 59.3%, the mean age of the subjects was 43.7 $\pm$ 20.1 years. The admission and mortality rates of the patients in the airport group were relatively higher (35.1% and 2.6%, respectively) than that of those in the direct ED visit group (21.6% and 0.5%, respectively). Abdominal disease was the most common medical problem, and the most common causes of death were sudden cardiac arrest and acute myocardial infarction. Future prospective studies are necessary to affirm its findings.

Keywords

Epidemiology; Emergency; Airport

1. Introduction

Air travel is becoming increasingly frequent worldwide. Before the outbreak of the coronavirus disease, the speed and comfort of air travel prompted 4.5 billion passengers to travel through commercial airlines annually [1]. It is estimated that more than half of all airplane passengers will be aged $\geq$50 years by 2030. Some previous literature have suggested that as the global population is getting older and number of aircraft passengers is gradually increasing, the frequency of urgent medical events during flights has gradually increased [2, 3].

Although aircrafts depart and return to terra firma, they generally cruise at an altitude of 10,000 m, which entails changes in environmental conditions, including hypoxia, low pressure level and humidity, and prolonged sitting, that might be stressful for special individuals [4, 5]. Extended exposure to these stressful conditions might lead to in-flight medical emergencies (IMEs) which while not common are not rare either. The prevalence of IMEs is 1 in every 604 flights [6].

Several studies have focused on the symptoms, prevalence, and in-flight emergency care aspects of IMEs [7–12]. However, there have been no studies on the aspects of patients and treatment outcomes of emergency medical events that occur in airports, a special environment in which emergency medical systems are less accessible due to security and take-off and landing reasons.

In this study, we explored the characteristics and treatment outcomes of patients with various symptoms, who had emergency medical events at an airport.

2. Materials and methods

Our hospital is a tertiary academic hospital that is the primary and unique referral hospital for Incheon International Airport, the biggest airport in South Korea and 16th most frequently visited airport worldwide [13]. Clinics in Incheon airport are directly managed by our hospital, and most patients in need of emergency transfer are accommodated in our center.

2.1 Data collection and variables

This is a descriptive cross-sectional study using medical records. We reviewed all cases of patients who visited our emergency department (ED) for emergency medical events that occurred at Incheon International Airport between May 2013 and April 2018; which encompasses all severe IME cases transferred from airport clinic for further evaluation or emergency treatment and also cases occurred at the airport which not on flight. The sex distribution, age distribution,

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medical or other diseases (trauma, delivery, intoxication, and others), disposition, and mean length of stay (LOS) of the study subjects were analyzed and compared with those of the general population that visited our ED. The severity classification used Korean Triangle and Acuity Scale (KTAS). KTAS is a severity classification standard developed based on Canadian Triangle and Acuity Scale and currently being used [14–16]. According to the result of KTAS classification, level 1 was classified as serious, level 2 as severe, level 3 as moderate and level 4, 5 as slight.

2.2 Main outcomes

We conducted a retrospective comparative analysis of all patients who visited our hospital ED, including airport ED visits and direct ED visits, between May 2013 and April 2018. A demographic comparative analysis was conducted between the airport ED visits group and the direct ED visit groups. The clinical outcomes of the study subjects, including their disposition and LOS in the ED, were reviewed and all parameters were compared with those of the patients who visited the ED directly. Classification according to their disease entity and triage of their severity of the study group were carried out; a comparative analysis of incidence between 3 groups of age-children (aged <15 years), adults (aged 15–65 years), elderly (aged >65 years) was done, apart. Dead patients among the study subjects were reviewed separately, including their age, sex, nationality, chief complaint and cause of death and their most common cause of death and chief complaints were identified.

2.3 Statistical analyses

Categorical variables are expressed as numbers and percentages, and continuous variables are presented as means and standard deviations in the description analysis. We performed a comparative analysis of the two groups using a Chi-square test for categorical variables and a Mann-Whitney U test for continuous variables because the sample size was extreme. Both Chi-Square and Mann-Whitney U tests are non-parametric tests and are robust when the sample sizes are not equal. All reported p values were two-sided. Statistical significance was set at $p < 0.05$. Stata software version 16 (StataCorp, College Station, TX, USA) was used for the analyses.

3. Results

During the study period, 258,823 patients visited the ED of our hospital. Of these, we excluded 2933 patients who visited the ED for simple medical records without consultations and 32 patients with unknown age and sex. A total of 255,858 cases were finally included in the analysis; of these, 846 (0.3%) were cases transferred from the airport, whereas 255,012 (99.7%) were direct ED visits (Fig. 1).

3.1 Demographic characteristics

A comparative analysis of the demographic data showed differences between the two groups (Table 1). The male-to-female ratio in the airport group (59.3% vs. 40.7%) was higher than that in the direct ED visit group (53.8% vs. 46.2%) ($p < 0.01$). Of note, the proportion of children aged <15 years in the airport group was much lower than that in the direct ED visit group (8.2% vs. 33.5%). In contrast, the proportions of adults (aged 15–65 years) and elderly persons (aged >65 years) in the airport group were higher than those in the direct ED visit group (adult: 75.1% vs. 51.3%, elderly: 16.8% vs. 15.2%, respectively). The average age at the time of visit was significantly higher in the airport group than in the direct ED visit group (43.7 years vs. 33.4 years) ($p < 0.01$). Regarding types of disease, medical disease and injury accounted for 80.6% and 19.4% of all cases in the airport group, respectively, and 71.4% and 28.6% of all cases in the direct ED visit group, respectively. Thus, a significantly higher incidence of medical disease was noted in the airport group ($p < 0.01$).

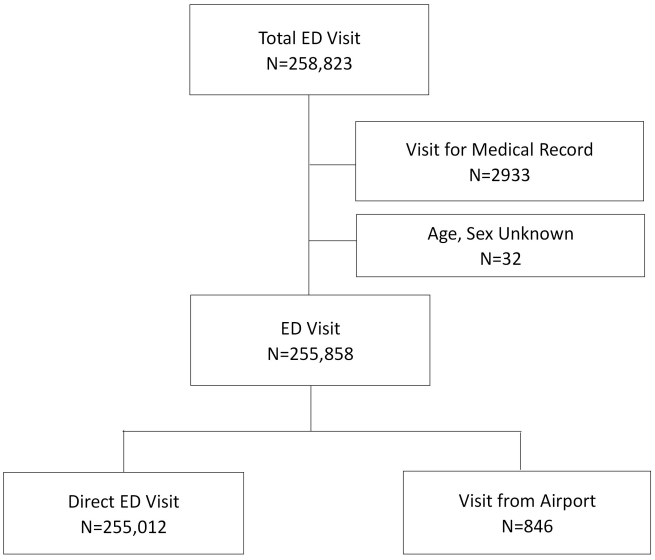

FIGURE 1. Patient flowchart. ED, emergency department.

3.2 Treatment outcomes of the study participants

A comparative analysis of the treatment outcomes of patients transferred from the airport and those of patients not related to flights was performed. The admission rate in the airport group was 35.1%, which was much higher than the 21.6% in direct ED visit group. The rate of transfer to other hospitals was 4.7% in the airport group and 0.8% in the direct ED visit group. The rate of discharge was much lower in the airport group (57.6%) than in the direct ED visit group (76.7%). Regarding the rate of death, the patients in the airport group markedly passed away more than those in the direct ED visit group (2.6% vs. 0.5%). The mean LOS in the emergency department appeared to be significantly longer in the airport group than in the direct ED visit group (297.1 $\pm$ 735.1 min vs. 147.9 $\pm$ 134.3 min; $p < 0.01$) (Table 1).

TABLE 1. Demographic characteristics of the study participants.

Variables	Total		Direct ED visit		Visit from airport		*p* value
	n	%	n	%	n	%	
Total	255858	100.0	255012	99.7	846	0.3	
Sex							<0.01
Male	137782	53.9	137280	53.8	502	59.3	
Female	118076	46.1	117732	46.2	344	40.7	
Age group							<0.01
Child (age <15)	85396	33.4	85327	33.5	69	8.2	
Adult (15 ≤ age < 65)	131433	51.4	130798	51.3	635	75.1	
Elderly (age ≥65)	39029	15.3	38887	15.2	142	16.8	
Average (mean ± SD), year	33.5 ± 26.5		33.4 ± 26.5		43.7 ± 20.1		<0.01
Disease type							<0.01
Medical disease	182815	71.5	182133	71.4	682	80.6	
Injury	73043	28.5	72879	28.6	164	19.4	
ED results							<0.01
Admission	56210	22.0	55193	21.6	297	35.1	
Transfer	2066	0.8	2026	0.8	40	4.7	
Discharge	196194	76.7	195707	76.7	487	57.6	
Death	1388	0.5	1366	0.5	22	2.6	
ED LOS (mean ± SD), min	148.4 ± 140.8		147.9 ± 134.3		297.1 ± 735.1		<0.01

ED, emergency department; LOS, length of stay.

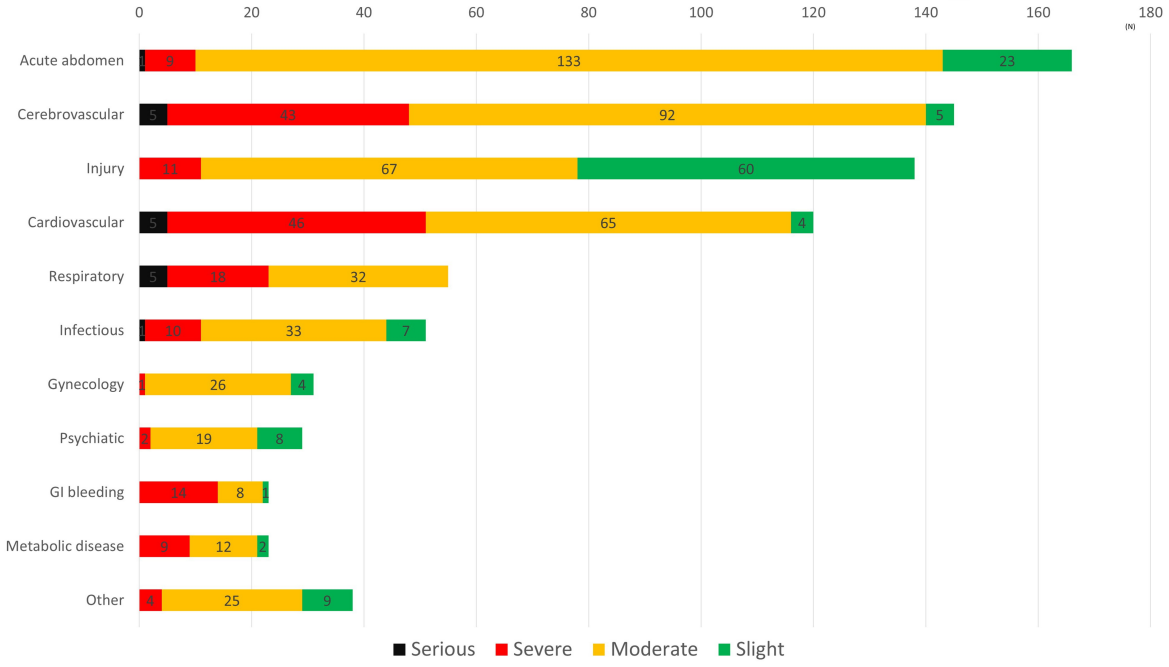

FIGURE 2. Diagnosis and severity of diseases among patients transported from the airport. GI, gastrointestinal.

3.3 Diagnoses and disease severity among patients transported from the airport

Among the 846 patients who needed emergency transfer from the airport to our hospital, the most common medical problem was acute abdominal pain (166 patients) (Fig. 2), followed by cerebrovascular problems (145 patients), injuries (138 patients), cardiovascular problems (120 patients, including 23 syncope patients), respiratory problems (55 patients), infectious problems (51 patients), gynecological problems (31 patients), psychiatric problems (29 patients), gastrointestinal (GI) bleeding and metabolic diseases (23 patients each), and other problems (intoxication and others) (38 patients).

The analysis of disease severity demonstrated that disease

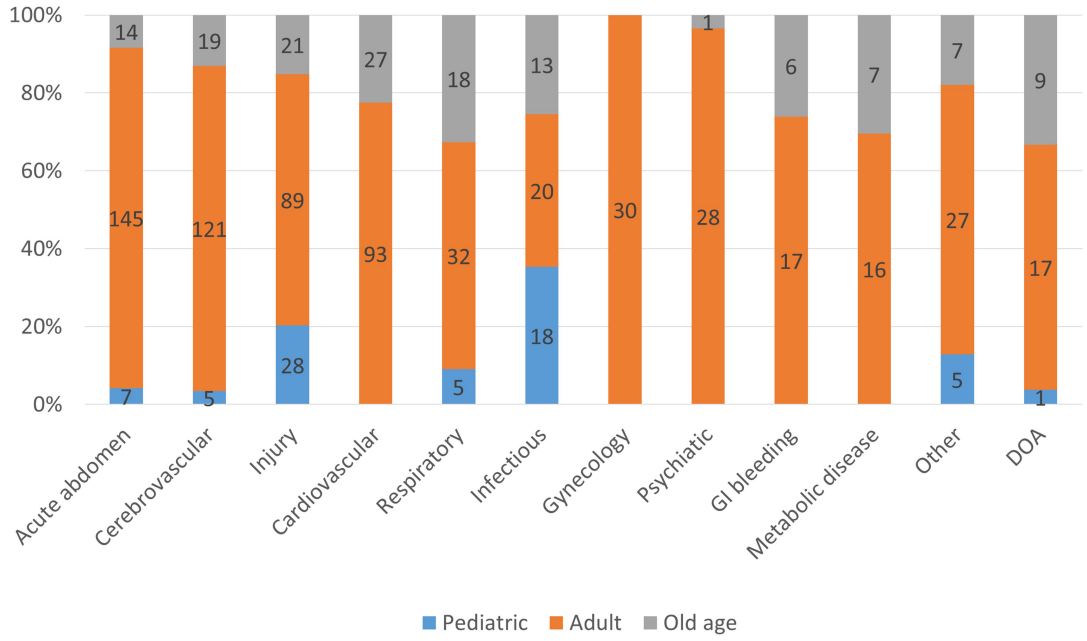

FIGURE 3. Age distribution according to disease diagnosis among patients from the airport. GI, gastrointestinal; DOA, dead on arrival.

severity was markedly higher in the GI bleeding group, with 60.86% of the cases being serious or severe (Fig. 2). Other medical problems that showed considerably high severity (serious and severe) included cardiovascular (42.50%), respiratory (41.82%), cerebrovascular (33.10%), metabolic (39.13%) and infectious (21.57%) problems.

To determine the age distribution according to disease, the patients were classified as children (aged <15 years), adults (aged 15–65 years), and elderly (aged >65 years). Except for gynecological problems, which were encountered only in a limited number of female patients of menstruating age, injuries (28 cases) and infectious diseases (17 cases) occurred most in the pediatric population. Abdominal (145 cases) and cerebrovascular (121 cases) problems were the most common medical problems in the adult population. Cardiovascular problems (27 cases), injuries (21 cases), and cerebrovascular (19 cases) problems were the most common in the elderly population (Fig. 3).

3.4 Analysis of dead patients

We reviewed all dead patient cases and recorded the age, sex, and nationality of the patient, year of visit, chief complaints, cause of death, and whether the patient had the medical event before departure or after arrival (Table 2). In dead patients, the most common chief complaints were "no respiration", and the most common causes of death were sudden cardiac arrest and acute myocardial infarction. Of the 36 patients who died, 22 died before arrival at the hospital or during emergency treatment, 14 died after admission to the intensive care unit. Regarding the nationality of the dead patients, 12 (33.33%) were South Korean, 11 (30.56%) were Chinese, 7 (19.44%) were American, 2 (5.56%) were Russian, 1 (2.78%) was Japanese, 1 (2.78%) was Senegalese, 1 (2.78%) was Indonesian, and 1 (2.78%) was Filipino. The number of male patients who died outweighed that of females (3.5-fold, 28 patients vs. 8 patients). The age of the dead patients ranged from 1 day to 83 years (53.5 ± 18.3 years). Ten patients were before departure, and 26 were after arrival at the airport.

4. Discussion

The analysis of the 846 patients who visited the ED from the airport showed that the most common medical problem diagnosed was related to abdominal pain. Comparative analysis demonstrated that the mean age of the patients in the airport group was higher, and the proportions of pediatric patients and injury-related visits were lower than that in the direct ED visit group. Regarding treatment outcomes, higher admission and mortality rates were identified in the airport group than in the direct ED visit group, and the most common causes of death were sudden cardiac arrest and acute myocardial infarction.

This study describes the clinical symptoms (chief complaints) of patients, who had emergency medical events in an airport, which is a unique environment, their demographic classification, diagnoses, and treatment outcomes after proper consultation and examination in a tertiary hospital emergency medical center. Our study is different from previous studies in that most previous studies showed data of inflight emergencies based on records written by flight-related personnel, using the initial chief complaints as a parameter to classify the patients. In addition, information on treatment outcomes and proper diagnosis were not included in those studies [7–12]. Some articles with information on proper diagnosis and treatment outcomes were focused on individual diseases, such as stroke, venous thrombosis, pulmonary thromboembolism, and pneumothoraxes [17–20]. Peterson *et al*. [6] conducted a large high-quality retrospective study on 11,920 IME cases, a thorough study that included descriptions of the symptoms of

TABLE 2. Chief complaint and cause of death of the dead patients.

No	Year	Arrival or departure	Chief complaint	Cause of death
1	2013	Arrival	Death on arrival	Sudden cardiac arrest
2	2013	Departure	Aspiration of food	Asphyxia
3	2013	Arrival	No respiration	Sudden cardiac arrest
4	2013	Arrival	No respiration	Pulmonary embolism
5	2013	Arrival	Dyspnea	Malignant melanoma
6	2014	Arrival	Mental change	Intracerebral hemorrhage
7	2014	Arrival	Mental change	Asphyxia
8	2014	Arrival	Dyspnea	Pulmonary embolism
9	2014	Arrival	No respiration	Sudden cardiac arrest
10	2014	Arrival	Dyspnea	Upper gastrointestinal bleeding
11	2014	Arrival	No respiration	Subarachnoid hemorrhage
12	2014	Arrival	No respiration	Sudden cardiac arrest
13	2014	Departure	Unspecified chest pain	Acute myocardial infarction
14	2014	Arrival	Chest Pain	Acute myocardial infarction
15	2014	Arrival	Mental change	Intracerebral hemorrhage
16	2014	Arrival	No respiration	Sudden cardiac arrest
17	2014	Arrival	Post-CPR state	Acute myocardial infarction
18	2015	Departure	No respiration	Child C liver cirrhosis
19	2015	Arrival	No respiration	Child C liver cirrhosis
20	2015	Arrival	Cardiac arrest	Acute myocardial infarction
21	2015	Arrival	No respiration	Sudden cardiac arrest
22	2016	Arrival	No respiration	Sudden cardiac arrest
23	2016	Arrival	Dyspnea	Hepatocellular carcinoma
24	2016	Arrival	No respiration	Hyperkalemia
25	2016	Arrival	No respiration	Sudden cardiac arrest
26	2017	Departure	No respiration	Sudden cardiac arrest
27	2017	Departure	Cardiac arrest	Sudden cardiac arrest
28	2017	Arrival	Dead on arrival	Sudden cardiac arrest
29	2017	Arrival	No respiration	Pulmonary embolism
30	2017	Arrival	No respiration	Sudden cardiac arrest
31	2017	Departure	Dead on arrival	Sudden cardiac arrest
32	2018	Departure	Loss of Consciousness	Hepatocellular carcinoma
33	2018	Arrival	No respiration	Acute myocardial infarction
34	2018	Departure	No respiration	Acute myocardial infarction
35	2018	Departure	Mental change	Hepatocellular carcinoma
36	2018	Departure	Dead on Arrival	Drowning

CPR, Cardiopulmonary resuscitation.

IMEs, classification of the patients after consultation, and their treatment outcomes. Nevertheless, a detailed demographic classification was not included in that study [6]. A similar study based on the clinic in an airport was performed in Japan. A certain number of cases of mild severity was included in that study. Information regarding disease severity was derived from clinical data, and the severity of transferred cases and their outcomes were described in limited detail, with only 36 cases mentioned [21].

The data of the present study showed that 0.5 emergency patients were transferred to our center per day. This is a lower number than the 3–4 patients per day reported in a Japanese airport clinic study [21], and the 2.7 cases per day reported in the study by Peterson *et al.* [6]. This difference could be attributed to the nature of our center, which is a tertiary referral hospital where more severe cases are referred to from

the airport clinic. The number of patients transferred annually increased gradually, with 122 patients in the first year of study and 277 patients in the fifth year; 7.2 deaths were recorded per year, a result similar to the 7–8 cases per year reported in Japan and 5.64 cases per year reported in the study by Peterson *et al*. [6].

Regarding disease entities, syncope was not included in our classification criteria. The final common pathway of syncope is the same regardless of the underlying cause: about 10 s of complete disruption of blood flow or nutrient delivery to both cerebral cortices or to the brainstem reticular activating system, or reduction of cerebral perfusion by 35%–50%. More commonly, an inciting event causes a drop in cardiac output, which decreases oxygen and substrate delivery to the brain [22]. The Framingham Heart Study described the most common causes of syncope, which included vasovagal (reflex mediated, 21%), cardiac (10%), orthostatic (9%), medication-related (7%), neurologic (4%), and unknown (37%) causes [23]. Each syncope case in the present study was classified into categories of proper disease entities, except for syncope cases of unknown causes, which were classified as cardiovascular cases.

Excluding syncope, abdominal pain was the most common symptom of IMEs in most previous studies, with incidences ranging from 9.8% to 32.2%, which is in accordance with the 19.62% noted in our study data [6–12, 21]. Cerebrovascular diseases were the second most common reason (17.13%) for transfer to the ED in the present study. The Japanese study indicated that cerebrovascular disease was the second most common reason (10.9%) for transfer to the hospital, but fifth from the clinical data.

There are some limitations to the present study. First, analysis was limited owing to the retrospective nature of the study. Second, generalization of the findings can be limited because the study was performed in a single center. In addition, regional characteristics could be involved because of the urban location of the center. Third, although most emergency cases were transferred to our center and enrolled in this study, some cases could be omitted owing to the situation of the center or a patient's strong objection to transfer.

5. Conclusions

The group of patients who visited our emergency center from the airport had a lower proportion of pediatric patients, higher disease severity, and a higher LOS than those who directly visited the emergency center. Analysis of the consultation data of the center indicated that abdominal disease was the most common medical problem, and that mortality was higher among the group of patients who visited our emergency center from the airport than among the group of patients who visited the center directly. Regarding dead patients, the proportion of males among the dead patients was 3.5 times higher than that of females. The most common causes of death were sudden cardiac arrest and acute myocardial infarction. More thorough, larger, and prospective studies of different medical events in airports are necessary.

AUTHOR CONTRIBUTIONS

Conceptualization—DJY, YJL, JHP. Data curation—DJY, YJL. Formal analysis—YJL. Methodology—YJL, WKL, SK. Supervision—SBH, JHK, AD, JHP. Writing—original draft—DJY, YJL. Writing—review & editing—YJL, WKL.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was approved by the Institutional Review Board of Inha University Hospital (IRB No. 2019-04-009). The board waived the need for informed consent.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY

The data used to support the findings of this study are available from the corresponding author upon request.

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