Research Article

A Series of Three Aircraft Emergency Public Health Alerts at an International Airport Over a Six Week Period due to Suspected Contaminated Cabin Air

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Abstract

Air travel is a safe, common mode of transport for both work and leisure activities. It can be associated with health risks, with exposure to toxic compounds or fumes in the aircraft cabin resulting in a variety of clinical symptoms. We report on three aircraft incidents which resulted in passenger and crew illness and necessitated emergency landings at Dublin International Airport.

We obtained details on the three incidents from the National Ambulance Service Operations Centre dispatch system and staff, regional public health specialists and the National Air Accident Investigation Unit (AAIU). We conducted a chart review of all passengers and crew who attended the hospital Emergency Department (ED) and consulted with the attending ED physician.

Twenty-three crew and passengers reported feeling unwell on the three flights over a six week summer period. Symptoms included dizziness, headache, and throat and eye irritation. On one flight there was a severe odour. Fifteen crew and passengers from the first two incidents were treated at a hospital ED. One

case had a low oxygen saturation, and another required oral steroids and nebulised bronchodilator. The AAIU did not find a cause for illness on assessment of all three aircraft.

The three aircraft incidents described highlight the potential safety risk of air quality alterations. While there is no evidence that serious health events occurred in these events, sharing of experiences on similar events may lead to increased understanding of these complex events and ensure that aircrafts are a safe environment in which to travel and work.

Keywords: Aircraft; Air quality; Fume event; Aircrew; Passengers; Emergency; Cabin air; Aerotoxic syndrome

1. Introduction

Contaminated cabin air during airplane travel can be associated with public health risks [1, 2]. Contaminants which present a risk of toxic exposure in the aircraft interior include exhaust gases, carbon monoxide, aviation fuel, hydraulic fuel, engine lubricants, fire extinguishing substances, carbon dioxide and oxygen contamination [3, 4]. Exposure may be acute and lead to immediate signs and symptoms, or may occur over time, with symptoms developing gradually [4]. Exposure to these substances can produce a range of neurological, respiratory, gastrointestinal and eye symptoms and can lead to impaired judgement and increased risk of human error in cabin crew [5]. It is vital that flight crews are aware of the risk of exposure to toxic chemicals, are protected and are equipped to take action.

We report on three separate in-flight incidents which resulted in unscheduled emergency landings and aircraft evacuation at Dublin International Airport involving three aircraft travelling to the United States in May and June 2014. Public Health alerts were activated in all three incidents involving national ambulance services, regional public health response and assessment at a major hospital Emergency Department (ED). On board exposure to toxic chemical substances was considered a possible reason for the incidents. We present the investigations and findings with recommendations.

2. Materials and Methods

We obtained details from regional Public Health department Medical Officer of Health respondents to incidents and reviewed incident reports. We interviewed paramedics and airport fire personnel attending incidents and reviewed reports from the National Ambulance Service Operations Centre computer assisted dispatch system. We obtained details from the attending airport duty manager where needed.

We interviewed the attending Emergency Department consultant and we performed a chart review of all crew and passengers who attended the relevant Dublin hospital ED. Chart data collected included demographics such as age and sex of attendees, seat number or designated work section of the cabin if crew and if an odour had been noticed in the cabin or not. Information on respiratory, cardiovascular, ocular, skin, and gastrointestinal symptoms, as well as relevant investigation results, was also collected from the medical charts.

We spoke with the head of the National Air Accident Investigation Unit **(AAIU)**.

3. Results

For each incident the Public Health Airport Alert was activated by the airport. The alert involved the regional Medical Officer of Health (MOH) at the local Department of Public Health, Health Service Executive East region being contacted by the National Emergency Operations Centre regarding an aircraft emergency due to a health incident on board, requiring emergency landing. At Dublin International Airport, the airport response included fire officer assessment in two instances, and all aircraft underwent further engineering examination. As part of the health response, paramedics from the national ambulance service carried out a risk assessment with the regional MOH, boarded the plane and interviewed the passengers and crew on the plane. The MOH advised on management and liaised with the same receiving hospital for all incidents.

3.1 Incident 1

On May 10th 2014 an aircraft en route from Venice, Italy to Philadelphia, USA reported a major emergency on board and the flight diverted to Dublin International Airport and a Public Health Airport Alert was activated. Twelve crew members reported feeling unwell. Symptoms included dizziness, eye irritation, nausea and headache. One passenger reported shortness of breath and was treated with inhaled salbutamol but did not acquiesce to transfer to hospital. Crew members reported an unusual, strong, perfume-like odour to the rear of the plane. Nine crew members were transported to hospital for further medical assessment.

Fire officers inspected the plane on its arrival at Dublin and dismantled both front and back galleys. An engineer assessment was also carried out. Neither assessment revealed an abnormality. All passengers were accommodated on alternative flights the following day. The pilot flew the airplane, without passengers, to its destination the following day.

3.1.1 Medical assessment of ill crew in incident 1:

The nine crew brought to hospital were suffering from a range of symptoms including dizziness, headache, throat irritation. They were each assessed by the ED medical personnel (Table 1). Electrocardiograph and temperature were within normal parameters in all nine cases. Arterial blood gases revealed a pulse oximetry of 95% and a slightly low oxygen saturation of 9.24 kPa in one female who had complained of burning throat and dizziness (normal range greater than 10.5 kPa). No evidence of acute illness was found and the nine crew members were discharged from the ED after several hours.

	Incident 1		**Incident 2**		**Incident 3**	
Date	10th May		19th May		25th June	
	n	%	n	%	n	%
Total ill	9		6		10	
of which crew	9		5		8	
of which passenger	0		1		2	
Age in years mean (range)	49 (43-60)		50 (39-61)		unknown	
Cabin section						
Rear	4	44	0	0	0	0
Front	4	44	3	50	0	0
Unknown	1	22	3	50	8	100
Odour reported on plane	Yes		No		No	
Symptoms reported						
Dizziness	8	89	5	83	8	100
Headache	5	56	0	0	0	0
Throat burning	3	33	3	50	0	0
Eye irritation	3	33	3	50	0	0
Cough	1	11	1	17	0	0
Short of breath	1	11	0	0	8	100
Skin flushing	1	11	0	0	0	0
Blurred vision	1	11	0	0	0	0
Palpitations	1	11	0	0	0	0
Chest tightness/ pain	0	0	1	17	0	0
Nausea	0	0	1	17	8	100
Signs						
Low oxygen level on arterial blood gas (≤ 95%)	1	11	No tests	-	No tests	-

Table 1: Medical assessment of ill at hospital emergency department.

3.2 Incident 2

On May 19th 2014 an aircraft en-route from Venice, Italy to Philadelphia, USA was 550 miles into its journey when the pilot returned to make an unscheduled emergency landing at Dublin International Airport. Three crew members reported symptoms of illness. These included dizziness, throat burning and eye irritation. All three ill crew members were stationed at the front of the plane.

Subsequently, following activation of a Public Health Airport Alert, the MOH was advised that five crew

members and one passenger were unwell. All six were transported to a hospital ED for further medical assessment (Table 1). The receiving hospital was aware of having managed symptomatic crew from the first incident nine days previously.

An examination of the plane was undertaken by an aviation engineer; no abnormality was found. There was no unusual odour reported during this incident.

3.2.1 Medical assessment of ill passenger and crew in incident 2: The five symptomatic crew and one passenger were interviewed and examined by the ED consultant. On assessment one crew member complained of chest pain, cough and dizziness. She received single doses of oral prednisolone and nebulised salbutamol and ipratropium bromide and made a full recovery. The ED consultant's impression was that there was genuine illness among those who presented, possibly due to exposure to an irritant gas or chemical. Although the other five patients complained of a variety of symptoms (Table 1), there was no abnormality detected on clinical exam or relevant investigations. Arterial blood gases were not carried out. All six were discharged from the ED.

3.3 Incident 3

On June 25th 2014, a flight from Dublin to Boston, USA returned to Dublin due to crew illness on board. Eight of ten crew (all crew, except the pilot and co-pilot) reported feeling unwell. Two passengers also experienced symptoms. The pilot reported a concern over air quality. Crew reported nausea and dizziness. It was reported that they felt that their oxygen levels were low. It was agreed that the airport paramedic would assess the situation and transport the ill crew members to hospital for medical assessment.

On landing there was no reported chemical or burning smell and the fire officer did not attend. The symptomatic crew members did not appear ill on arrival and despite initial plans for ED assessment they did not attend hospital.

3.4 All incidents

In all of the above incidents the AAIU examined the aircraft and reported no abnormal finding on aircraft inspection. There was specifically no leak in the engines or air-conditioning. In none of the three incidents did crew report eating the same food or exposure to any common source of infection. We requested further information from the airlines following their internal investigation but did not receive any update.

4. Discussion

This series of public health alerts in aircraft crew and passengers resulted in the mobilisation of a considerable health response in Ireland and with major cost for the airport authority and the airlines. Although deterioration in cabin air quality appears to be a factor, the exact reasons for the serious reported illness in crew and passengers necessitating flight diversions are unclear. On one occasion there was a distinct and unusual odour apparent to the airplane crew and to the fire crew who attended at the airport.

In this series, complaints of an insidious neurologic systemic nature with an irritation component were prominent, with dizziness, headache, eye irritation and burning throat being the leading symptoms. Crew rather than passengers were mainly affected. Symptoms were severe and deteriorating enough to require emergency landings, and the attending ED consultant reported his belief in some irritant gas or chemical effect. Carbon monoxide gas poisoning

symptoms did not occur, and carbon monoxide was not specifically tested for. Oxygenation levels were normal when measured using arterial blood gases in incident 1, apart from one crew member who was hypoxic.

There are many factors to take into account when assessing the risk of an exposure to a potential toxic substance [4]. These include identification of the substance, duration, dose and route of exposure, age, previous exposure, underlying medical conditions and individual variability such as genetic susceptibility. The role of emotional, psychological or other factors is difficult to account for [3]. Transit time in returning to land can dissipate any odours.

Air quality in aircraft cabins in general is felt to exceed that of enclosed spaces on the ground, but there have been regular reports on poor cabin air quality incidents [2]. A recent discussion paper describes the epidemiological evidence around these as being hampered by inconsistency in reporting of incidents and small numbers [3]. Air contamination reports are relatively uncommon, with fume events estimated to occur on 0.05% of flights overall (1 in 2000) [3]. The spectrum of reported symptoms in our series fits with symptoms in other reports on air quality incidents and in case studies of acute events: namely neurotoxic, neuropsychological, respiratory and irritant events [4, 5].

While there has been attention on aircraft cabin air environment, there is a relative dearth of literature on the objective health effect on airline staff following possible contamination of cabin air and this remains under debate. Early studies citing problems of poor aircraft cabin air quality addressed only general flight experiences of flight attendants [6].

The possible effects on the health of crew of oil, hydraulic fluid smoke or fume contamination incidents in pressurised aircraft have been summarized [3]. Specific concerns have been raised with respect to organophosphate compounds in the cabin air environment and the perceived effects on health of long term low level exposure [3, 7]. Recent studies of acute and chronic exposures concluded there was a cause and effect relationship linked to the occupational environment [2] and that aerotoxic syndrome with irritancy, sensitivity and neurotoxicity following exposure to atmospheric contaminants is a discrete occupational health condition, though ‘hidden’ [4], which can be acute or chronic. There is a high prevalence of reports from airline pilots of memory loss, headaches, dizziness, tunnel vision and other neurotoxic effects [7]. In one cross-sectional study, flight crew had poorer self-reported health, including higher rates of depression and anxiety, than the general population, [8].

Aerotoxic syndrome is not recognised as an entity by the Aerospace Medical Association [3, 9]; citing symptom inconsistency and variability, similarity to symptoms frequently experienced by both the general population and population subsets encountering chronic hyperventilation or cognitive overload [3, 10].

In the absence of any abnormal finding by engineers, it is not possible to accurately speculate about the exact cause of passenger and crew illness in any of these incidents. Aircraft system faults can cause alteration in air quality, for example due to the generation of toxic substances from fluid leaks,

chemical fumes from burning wires or exhaust fumes. Tricresyl phosphate (TCP) has been frequently used in aircraft engine oil. Bleed air provided to the flight deck and cabin for air-conditioning can contain traces of TCP which can cause neurotoxic effects in humans [7]. When there is a leak in the system this can be associated with an oil/heat based smell (Personal communication AAIU, Ireland 2015). At high concentration petrochemicals and other mechanical fluids are very irritating to the upper respiratory tract with exhaust exposures causing a detection of an unpleasant smell, irritation of the eyes, nose and throat and headache [11].

Gases such as nitrogen dioxide are very irritating to the upper respiratory tract at high levels. Because of increased fuel cost, re-circulated air is often used in the cabin [12]. Lindgren et al measured air pollutants in cabin air during cruising for 26 intercontinental flights. The mean cabin concentration of measured chemical contaminants was low and the mean NO_2 and O_3 were highest in the cockpit and in the forward galley [13].

There is no sampling or test equipment on board aircraft to investigate air quality when a smell is first observed (personal communication AAIU, Ireland 2015) and no requirement for such sampling. Flight crews must periodically self-monitor for possible signs and symptoms of exposure to toxic chemicals. Immediate action may be required such as improving ventilation, reducing altitude, and if needed, emergency landing with evacuation of the aircraft.

This series demonstrates the presence of potential safety issues for crew and passengers from air quality alterations. Even a slight degree of in-flight impairment is hazardous to a pilot's task [14]. In the third incident every crew member except the pilot and co-pilot reported illness, posing a potential risk to passenger safety.

5. Conclusion

Airlines and crew should continue to be cognisant of the potential for toxic exposure within the aircraft and the means to alleviate the situation by rapid ventilation, descent and indeed landing the aircraft urgently [14]. Improved surveillance of cabin air quality with sampling tests on board to rapidly assay for major contaminants would benefit crew and passengers. Fortunately onboard second-hand tobacco smoke is no longer a hazard for flight staff but our series prompts the need for ongoing air quality monitoring and additional reporting on suspected air quality incidents [15]. Further investigation of the health effects of occupational exposure to variations in air quality and low level toxin exposure is needed. There is no evidence from this report of serious health risk following these incidents; however further studies are needed on human health during and following these type of 'fume events', including biomonitoring. Health protection for aircraft crew and passengers is vital. Sharing of health information on incidents such as this series may lead to a heightened awareness and understanding of the complexities of maintaining a safe environment and workplace climate for aircraft staff and those involved in aircraft travel.

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