

Article

Commercial Aircraft Assisted Suicide Accident Investigations Re-visited –Agreeing to disagree?

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Abstract: The number of aircraft assisted suicides can only be considered as a rough estimate, because it is difficult and at times not possible to identify all cases of suicide. Methods: Four recent reports of accidents, occurring in 1997 in Indonesia, 1999 in Massachusetts in the United States, 2013 in Namibia and 2015 in France, which have been related to commercial aircraft assisted suicides were analyzed. The nature of this analysis is explorative. Results: In all four accident reports flight data recorder (FDR) data were available. Cockpit voice recorder (CVR) data were available as well except for one accident where CVR data were only partially available. Comprehensive medical and psychosocial histories were available in only one of four of the accident reports. Conclusion: To prevent accidents involving commercial aircraft, it is necessary to identify the causes of these accidents to be able to provide meaningful safety recommendations. A detailed psychological autopsy on pilots can and likely will assist in investigations, as well as generate recommendations that will substantially contribute to mitigate accidents due to pilot suicide. Airborne image recording may be a useful tool to provide additional information about events leading up to a crash and thus assist in accident investigations.

Keywords: aircraft assisted suicide; accident investigation; CVR; FDR; airborne image recording; psychological autopsy

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1. Introduction

Research into aircraft assisted pilot suicides is based on official accident investigation reports that analyze and conclude the likely cause of an accident [1, 2]. Based on accident reports in the United States over almost a 20-year period (1993–2021) 24/7244, fatal accident cases in general aviation were concluded to be due to aircraft assisted suicides [0.33% 95% CI 0.21–0.49] [1].

This estimate, and others, of aircraft assisted suicides can only be considered as a rough estimate, because it is difficult and at times not possible to identify all cases of suicide. Furthermore, many cases involve private (single acting) pilots or those of very small operators where investigations may be more limited, as opposed to the rarer intentional crashes brought about with large passenger aircraft. There are several factors that need to be analyzed before judging an accident to be caused by pilot suicide.

It is very important to define what is meant by ‘suicidal behavior’. Goodfellow et al. [3] carried out a systematic literature review and analyzed 29 articles and book chapters. They concluded that there are four main factors related to assessing suicidal behavior: agency, knowledge of fatal outcome, intent, and outcome, which will aid in understanding the meaning of suicide in different cultures. It is therefore important to note that the

nomenclature of suicidal behaviors varies and makes comparisons between different studies challenging [4].

In a comprehensive comparative study by Mann et al. [5] of 14–72-year-old patients who had attempted suicide following admission to a psychiatric clinic with patients who had never attempted suicide, it was found that severity of their current depression did not distinguish these two groups. Therefore, severity of mood was not found to be a predictor of suicidal behavior. Suicide related factors were also studied recently in a systematic review [6]. Some of these factors related to suicide are listed in the Table 1.

Table 1. Examples of factors potentially related to suicidal behavior [5, 6].

Factor
Any mental disorder
Any personality disorder
History of self-harm
Relationship conflict
High scores on suicidal ideation
Fewer reasons for living
Rates of lifetime aggression
Impulsivity
Unemployment
Positive family history of suicide

Mann et al. [5] found several comorbidities related to suicidal behavior. These comorbidities included past substance use disorder or alcoholism and family history of suicidal acts.

A study of road accidents in Sweden (i.e., a re-analysis of a 2012 study) by Andersson and Sokolowski [7] showed that by using an extended psychosocial investigation the number of the accidents due to suicide was 63% higher than originally estimated. Accident investigation related to traffic accidents needs to include socio-economic background as well as psychosocial and mental health factors. The factors that need to be collected are very similar to those included in Columbia-Suicide Rating Scale [8, 9].

Given the uncertainty and different factors that can be applied, we analyzed four accident reports which have been related to commercial aircraft assisted suicides that occurred between the years 1997 and 2016. The aim was to identify how the various aircraft accident investigators arrived at the conclusion that the accidents were due to suicidal acts. Based on these analyses and **experience**, recommendations to mitigate future aircraft assisted suicides are considered to investigate accidents in which there are suspicions of possible aircraft assisted suicide.

2. Materials and Methods

Four accident reports which have been related to commercial aircraft assisted suicides were analyzed [10–13] (Table 2). The nature of this analysis is explorative. This analysis relied on data extracted from the accident reports that supported aircraft assisted suicide from: (a) cockpit voice recorder (CVR) and flight data recorder (FDR), (b) medical history, (c) psychosocial history, (d) toxicology, (e) autopsy and (f) any methodology that utilized aviation medicine. Additionally, **critical responses** by another accident investigation authority were analyzed in two of the cases [10,11]. Also, safety recommendations to mitigate future similar kinds of accidents were analyzed regarding the two more recent accidents [12, 13].

Table 2. Analyzed accidents [10–13].

Accident Country, Date, Flight	Aircraft	Accident Suspected pilot related to accident Pilot. age (years)	Flight (hours) Last medical examination (Category)	Fatalities Crew Passengers	Accident Investigation Authority
Indonesia, 19 Dec 1997, MI185	Boeing 737-200	Indonesia Captain, 41	7173, 1 Nov 1997 (ATPL)	7 97	National Transportation Safety Committee (NTSC), Indonesia
Massachusetts, USA, 31 Oct 1999, MSR990	Boeing 767-366ER	Massachusetts, USA First officer, 59	12 538, 19 June 1999 (ATPL)	14 203	National Transportation Safety Board (NTSB), Washington, USA
Namibia, 29 Nov 2013, TM479	C9-EMC	Namibia Captain, 49	9052, Aug 2013 (ATPL)	6 27	Directorate of Aircraft Accident Investigation, Namibia
France, 24 March 2015, 4U9525	Airbus 320-211	France First officer, 27	919, 11 Febr 2014 [MPL(A)]	6 144	Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA), France

3. Results

These accidents were investigated by the national aircraft accident investigation authorities from Indonesia, United States, Namibia and France, respectively [10–13]. In total, 33 cabin crew members and 471 passengers died due to these accidents. In two cases, the suspected pilot related to the accident was the first officer and in two cases it was the captain. All the suspected pilots were males and between the ages of 27 and 59 years (Table 2).

In all four accident reports FDR data were available [10–13]. CVR data were available as well except for the Indonesia flight MI185 (in 1997) where CVR data were only partially available [10].

Medical and psychosocial histories were available in only one [13] (BEA, 2015) of four accident reports. In two accidents psychosocial histories were partly available [10, 12].

Table 3. Documented medical and pathological information collected in accident investigations [10–13].

Analyzed Factor in Accident Investigation Report	Indonesia, 19 Dec 1997, MI185	Massachusetts, USA, 31 Oct 1999, MSR990	Namibia, 29 Nov 2013, TM479	France, 24 March 2015, 4U9525
Medical history (years)	—*	—**	—***	8 years

Medication(s) based on clinical data	-	-	-	+
Doctor's/hospital visits	-	-	-	+
Psychology visits	-	-	-	+
History of medical certifications	1 year	1 year	1 year	8 years
Doctor involved in analysis	-	-	-	+
Special doctor's team involved in analysis providing post-mortem diagnosis	-	-	-	+
Post-mortem toxicology	-	-	+	+
Identification	-	-	+	+

*Statement that no significant medical history was related to crew.** Close friend interviewed.

Table 3. Accidents Occurred in Indonesia and Massachusetts: Official Accident Report vs. Response to Accident Investigation Draft Report [10–13].

Accident, Country, Date, Flight	Accident Investigation Report Safety Investigation Authority, Summary and Probable Cause	Response to Accident Investigation Draft Report
	National Transportation Safety Committee	NTSB
	There was no evidence indicating that performance of either pilot was adversely affected by any medical or physiological condition.	There was no technical failure explaining the accident.
Indonesia, 19 Dec 1997, MI185	There was no evidence that there were difficulties between pilots.	The accident can be explained by intentional pilot action.
	Until stoppage of the CVR pilots conducted flight normally.	The flight profile was consistent with sustained manual nose-down flight control inputs most probably made by the captain.
	There was no evidence of a technical cause of the accident.	CVR was intentionally disconnected.
	The investigation yielded very limited data to make conclusions possible.	Recovery was possible but not attempted.
	NTSB	Egyptian Aircraft Accident Investigation Directorate
Massachusetts, USA, 31 Oct 1999, MSR990	The nose-down movements did not result from a technical failure.	NTSB has not done the necessary type of professional accident investigation.
	The initial airplane's movements were due to manipulation by the first officer.	The report selectively uses the facts of investigation to develop, support and

After the captain returned to the cockpit, he tried to recover the aircraft while the first officer pulled the nose-down. “prove” the findings of the deliberate act.

The report fails to account for specific facts in the record that refute the possibility of an intentional act. The probable cause for the accident was the first officer’s flight control inputs.

NTSB= National Transportation Safety Board.

In two accidents, the accident investigation authorities that conducted the investigations and the aviation authority that commented on the investigation had different interpretations to the cause of the accident (Table 3).

Regarding the accident in Indonesia in 1997, the local National Transportation Safety Committee did not find the accident intentional while the NTSB in contrast considered the accident intentional [10]. The NTSB report regarding the accident in Massachusetts considered it intentional while the Egyptian Aircraft Accident Investigation Directorate held the opposite view [11].

The safety recommendations because of the accident in Namibia were primarily oriented towards solutions related to the technical operation and the tracking of the aircraft [12]. This focus diminished the centrality of the pilot murder suicide. The safety recommendations because of the accident in France were related to the medical monitoring of pilots and the expansion of emotional support for pilots [13].

Table 4. Safety recommendations related accident in Namibia [12] and France [13].

Safety Recommendations Namibia, 29 Nov 2013, TM479*	Safety Recommendations France, 24 March 2015, 4U9525**
Mozambique CAA should ensure procedure of two people in the flight deck	EASA require that when a class 1 medical certificate is issued to an applicant with a history of psychological/psychiatric trouble of any sort, conditions for the follow-up of his/her fitness to fly be defined.
ICAO should establish a working group that creates threat management emanating from both side of the cockpit door	EASA include in the European Plan for Aviation Safety an action for the EU Member States to perform a routine analysis of in-flight incapacitation, with reference but not limited to psychological or psychiatric issues.
ICAO should establish a working group to review installation visual recording inside and outside cockpit	EASA, in coordination with the Network of Analysts, perform routine analysis of in-flight incapacitation, with reference to psychological or psychiatric issues.
Early warning system regarding abnormal flight behavior needs to expedite by ICAO	EASA ensure that European operators include in their management Systems measures to mitigate socio-economic risks related to a loss of license.
Aircraft tracking and localization system other than ELT needs to expedite by ICAO	EASA define the modalities under which EU regulations would allow pilots to be declared fit to fly while taking anti-depressant medication under medical supervision.

The World Health Organization develop guidelines for its Member States to help them define clear rules to require health care providers to inform the appropriate authorities when a specific patient's health is very likely to impact public safety.

EASA ensure that European operators promote the implementation of peer support groups to provide a process for pilots, their families, and peers to report and discuss personal and mental health issues, with the assurance that information will be kept in confidence in a just-culture work environment, and that pilots will be supported as well as guided with the aim of providing them with help.

*Quoted: [12]; **quoted: [13].

4. Discussion

Although suicide by deliberately crashing an aircraft is a rare phenomenon, its significance for flight safety and passengers' perception of aviation safety is important. This phenomenon is to some extent related to significant disasters occurring in society, and **it is still too early to assess whether the COVID-19 pandemic has had an impact** on suicidal behavior currently or in the near future [14–17]. In the investigation of air accidents, identifying and/or verifying an aircraft accident is due to assisted pilot suicide presents very special challenges [1].

The analysis of these four accident investigation reports revealed that the FDR and CVR information lends significant weight in determining whether the accident is the result of the pilot's aircraft assisted suicide. FDR registration was used in all four analyzed accident investigation reports. In addition, CVR registration was used in three cases and only partial CVR registration was used in one case [10–13]. The conclusion of a suicidal accident arose from the fact that no technical fault was found with the plane and the trajectory of the plane was very exceptional. As an example, an accident under investigation is flight MU5735 occurred 21 March 2021 in which according to the media no mechanical failure was found with the aircraft and FDR analysis preliminarily supports a potential intentional aircraft crash [18]. The final accident report has yet to be disclosed. CVR registration was used to support that the abnormal flight path was caused by the pilot's intentional action. In the accidents that occurred in Namibia in 2013 and in France in 2015, the CVR registration supported the pilot's deliberate controlled actions led to the accident [12, 13].

The remaining commercial aircraft crashes of significance occurred in Indonesia in 1997 and Massachusetts, USA in 1999 [10,11]. Interpretation of the information of CVR data was not entirely clear, which may have contributed to disagreement between accident investigation authorities [10,11]. The Directorate of Aircraft Accident Investigation of Namibia recommended that the ICAO should establish a working group to review installation of visual recording inside and outside the cockpit [12]. The issue of airborne image recorders and Annex 6 defining this approach has been discussed for several years in the ICAO [19]. The ICAO's working paper mentions several commercial airplane accidents where airborne image recorders would have provided additional information to assist in the accident investigation [20]. In general, airborne image recorders could be useful in cases of unlawful interference related to flight operations. Currently, there is an attempt by the ICAO to mandate airborne image recorders [19].

Psychological autopsy (PA) is a forensic assessment to evaluate the deceased's mental state and intent [21]. The purpose of a PA is to: (a) obtain motive and cause of death, (b) analyze conditions surrounding the death (c) analyze factors which impacted suicide risk (d) help family members and other shareholders with their restorative mechanisms, and (e) help in administrative functions [22]. It also helps in these circumstances to

determine the manner of death (natural, accidental, suicide, homicide). Due to complexity related to suicide this method has limitations, but it can be useful in addition to individual potential suicide investigations as well as in research [21, 23,24].

Based on our experience, we created a checklist for the PA to be carried out in aviation medicine related mental health cases. This evaluation needs to be used in co-operation with all those specialists involved in an accident investigation: accident investigators will likely call on the expertise of aviation and forensic psychologists, psychiatrists, the pilot's aeromedical examiner(s) (AME), regular personal doctors and human factors and flight safety personnel. Despite this evaluation rarely can there be absolute certainty about suicidal intent being the sole cause of an accident. In many accident investigation cases the main effort has been to analyze health information obtained from AME through periodical medical examinations. However, several studies have shown that pilots often only share some of their health information with the aviation doctor [25, 26]. It is also possible that the seriousness of the pilot's psychiatric illness has not been recognized. Early diagnosis of major psychiatric illnesses, like psychosis, may be challenging even for psychiatrists [27]. But recognizing psychotic symptoms is essential; a recent study has shown that psychotic symptoms associated with severe depression doubled the risk of suicide compared to the risk with severe depression without psychotic symptoms [28].

Unlike more specific and arguably more clearcut physiological determinants or causes of an air crash, such as cardiac or neurological symptoms, mental health and well-being factors, are less straightforward to determine. Their role may be a cofactor alongside others in order to assess whether human factors or mental ill health may be factors in an aircraft crash. Investigations will typically focus on several factors, which include (a) past and recent mental health and well-being history, (b) training records and any challenges or difficulties noted at the start of the pilot's career, (c) past and present family history of mental ill health d) relationship status, stability, dating patterns and challenges, (e) financial circumstances and difficulties, (f) employment and performance records with a focus on resilience and challenges, (h) occupational stress and security, (g) substance use and misuse history and (h) general life 'behaviors' such as internet use, addictions and dependencies, legal challenges and problems, and medical issues and problems. Of course, personality and past behavioral issues and patterns are a likely reasonable predictor of future behavior and will be subjects in an investigation as they can help shed light on the current accident and pilot's behavior. An example of a very specific type of aircraft accident is flight MH 370 which occurred 08 March 2014 [29]. The report is 450 pages long and under the title "Significant past medical and medication history" there are only about 20 lines of text. It is possible that there were no health issues with the pilots to report; but on the other hand, the aircraft has not been found and a carefully carried out psychological autopsy was not undertaken. In the current report, it is difficult to follow-up how the medical history was covered.

While this article focuses particularly on the significance of the psychological autopsy, it should be noted that aviation pathology and toxicology can contribute substantially to clarify the cause(s) of an accident [30-33]. Among these four analyzed accidents, two also included toxicological studies [12,13]. In the accident in France both escitalopram and mirtazapine were found in the analysis [13]. Interestingly, there is potential interaction between these drugs as consuming escitalopram with mirtazapine may increase the risk of a rare but serious condition known as serotonin syndrome [34]. Altogether different psychiatric drugs, as well as interactions of these drugs, may cause behavioral changes which need to be taken into consideration. Another issue to consider is the different distributions of a drug(s) between body fluids and tissues [35]. Unfortunately, trying to relate the post-mortem drug concentrations to those drug concentrations when the person was still alive is very demanding and at times impossible.

The main purpose of an accident investigation is to prevent similar accidents from occurring again. To this end accident investigation reports provide safety recommendations. In this analysis two accident reports provided mitigation recommendations to

prevent aircraft assisted suicides [12, 13]. The safety recommendations provided after the accident in Namibia accident were more technical in nature, and operations related compared to those given after accident in France by Bureau d'Enquêtes et d'Analyses pour la sécurité de l'aviation civile (BEA) were focused on psychiatric aviation health, support, and duty of notification [12,13]. It can be rightly argued that the recommendations of this French accident investigation report have contributed to the advancement of aviation safety.

5. Conclusion

In summary, to prevent what may arguably be preventable pilot suicide accidents involving commercial aircraft, it is necessary to identify the causes of these accidents to be able to provide meaningful safety recommendations. A detailed psychological autopsy on pilots can and likely will assist in investigations, as well as generate recommendations that will substantially contribute to mitigate accidents due to pilot suicide. Airborne image recording may provide additional information about events before the crash which may be helpful in assisting in an accident investigation.

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