

Meta-Analysis of Previously Unsolved Cases of Aviation Mishaps Employing Molecular Pathology

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Abstract : Background: Analyzing any aircraft accident is mandatory based on the regulations of the International Civil Aviation Organization and the respective country's criminal prosecution authorities. Legal medicine investigations are unavoidable when fatalities involve the flight crew or when doubts arise concerning the pilot's aeromedical health status before the event. As a result of frequently tremendous blunt and sharp force trauma along with the impact of the aircraft to the ground, consecutive blast or fire exposition of the occupants or putrefaction of the dead bodies in cases of delayed recovery, relevant findings can be masked or destroyed and therefore being inaccessible in standard pathology practice comprising just forensic autopsy and histopathology. Such cases are of considerable risk of remaining unsolved without legal consequences for those responsible. Further, no lessons can be drawn from these scenarios to improve flight safety and prevent future mishaps. Aims and Methods: To learn from previously unsolved aircraft accidents, re-evaluations of the investigation files and modern molecular pathology studies were performed. Genetic testing involved predominantly PCR-based analysis of gene regulation, studying DNA promoter methylations, RNA transcription and posttranscriptional regulation. In addition, the presence or absence of infective agents, particularly DNA- and RNA-viruses, was studied. Technical adjustments of molecular genetic procedures when working with archived sample material were necessary. Standards for the proper interpretation of the respective findings had to be settled. Results and Discussion: Additional molecular genetic testing significantly contributes to the quality of forensic pathology assessment in aviation mishaps. Previously undetected cardiotropic viruses potentially explain e.g., a pilot's sudden incapacitation resulting from cardiac failure or myocardial arrhythmia. In contrast, negative results for infective agents participate in ruling out concerns about an accident pilot's fitness to fly and the aeromedical examiner's precedent decision to issue him or her an aeromedical certificate. Care must be taken in the interpretation of genetic testing for pre-existing diseases such as hypertrophic cardiomyopathy or ischemic heart disease. Molecular markers such as mRNAs or miRNAs, which can establish these diagnoses in clinical patients, might be misleading in-flight crew members because of adaptive changes in their tissues resulting from repeated mild hypoxia during flight, for instance. Military pilots especially demonstrate significant physiological adjustments to their somatic burdens in flight, such as cardiocirculatory stress and air combat maneuvers. Their non-pathogenic alterations in gene regulation and expression will likely be misinterpreted for genuine disease by inexperienced investigators. Conclusions: The growing influence of molecular pathology on legal medicine practice has found its way into aircraft accident investigation. As appropriate quality standards for laboratory work and data interpretation are provided, forensic genetic testing supports the medico-legal analysis of aviation mishaps and potentially reduces the number of unsolved events in the future.

Keywords : aviation medicine, aircraft accident investigation, forensic pathology, molecular pathology

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