Aviation Medicine

Medical aspects of airline operations

I: Health and hygiene

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"... *the whole civil aviation industry is working to one end, namely the safe passage of an aircraft through a physiologically and physically hostile environment.*"[1]

On 25 August 1919 the first British regular scheduled international commercial air service began between London and Paris. That year also saw the inauguration of commercial aviation in France, Germany, and the United States. The growth of civil aviation has been such that about 765 million passengers travelled on scheduled commercial airlines in the Western world during 1982.[2] This and the following article deal with some of the medical aspects of supporting such a vast industry, both in the air and on the ground.

Commercial aircraft must be so designed, constructed, and managed that they meet the myriad national and international regulations governing every aspect of their use. Many of these regulations are of an engineering, technological, or administrative nature, but there are several areas, covering both routine and emergency operations, which are legitimately the concern of doctors in general and aviation medicine specialists in particular.

Hygiene

The well being and safety of all on board commercial aircraft may be seriously compromised if insufficient attention is paid to routine matters of health and hygiene. This would be most obvious if, for example, the crew were stricken by acute gastroenteritis[3]: hence the widely followed and sound advice to pilots that they should eat different dishes not only while on board the aircraft but also in hotels and restaurants before a flight.[4] Less obvious, perhaps, are the dangers inherent in poor airport sanitation arrangements whereby food may be easily contaminated or waste may attract scavengers.

CATERING

Ideally, catering must be of the highest hygienic standard so that food poisoning is avoided. Careful control over the food itself, the food handlers, and the premises in which food is prepared is essential.[5] Airlines prefer to supply and prepare food in their own kitchens, where control is easier, but this is not always possible. Kitchens operated by subcontractors must be supervised by the airlines (or, in the case of airport catering facilities, by the airport authority), and if even this is not feasible the right of inspection and batch sampling must be retained and implemented. Catering staff should undergo strict medical examinations before employment and be re-examined regularly thereafter; continuing instruction in food handling and hygiene should be encouraged. In the United Kingdom premises where food is prepared are governed by the Food Hygiene Regulations, which include measures such as bactericidal hand cleansers, hot water rinses, and the use of disposable hats and gloves.[6] The increased risks associated with certain foodstuffs (minced meat, shellfish, cold meat, and fresh cream) must be minimised. For example, the requirements for storage if food is not to be consumed immediately must be rigorously enforced: cold foods should be stored at $< 10°C$ while hot food should be stored at $> 62{\cdot}7°C$.[5 6] This is particularly important if the airline practices "double" or "return" catering, where food for both outward and return flights is supplied by the parent airport.

Aircraft are not always able to carry sufficient drinking water for a round trip and may have to "top up" during ground stops. All airports must therefore have a supply of pure water, which is palatable and free from colour, odour, and turbidity, together with a safe means of delivering it to aircraft.[7] Once on board drinking water may be supplied from small independent potable sources while other needs are met from a separate supply. Usually and preferably, however, because of the risk of contamination, all water on a large aircraft is of drinkable quality and is supplied from large steel or fibreglass tanks. A single aircraft may have "topped up" from several places during a long trip and so the World Health Organisation recommends that, however reliable a source may be, all supplies should be effectively chlorinated immediately before being loaded on the aircraft[5]: this is usually carried out in the airport water bowsers. Dechlorination before drinking is then necessary to ensure palatability; taste neutralising tablets are added by the crew after water has been drawn from the tanks. Micropore filters, whose primary function is to help neutralise chlorine, are fitted at all water inlets in some aircraft but may be a contamination hazard themselves unless they are changed regularly. All waste water is drained overboard and not held for later disposal. The possibility of atmospheric pollution by contaminated waste water has led to the suggestion that isolated and otherwise unexplained outbreaks of cholera in places underlying air routes from India and the Middle East may be due to infected effluent from overflying aircraft.[8]

SANITATION

Aircraft toilets, ideally numbering at least one per 25 passengers on long range aircraft, are essentially chemical closets which empty into retention tanks. (The ideal ratio is very

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optimistic: British Airways aim at one toilet per 32 passengers on long range aircraft while most short haul aircraft have one per 50 passengers.) The flushing mechanism is usually electric. Waste material is filtered and part of the liquid phase recycled for flushing after an appropriate chemical has been added. The chemical additive must meet stringent requirements, including consistent and efficient bactericidal and cleansing activity, aesthetic acceptability (odour and colour), and stability. The solid phase, and any remaining liquid, is held in the retention tank before being discharged after landing, ideally into a main sewer either directly from the aircraft or via a toilet waste vehicle. Clearly airports must have a fail safe disposal system and strict control of cleanliness: separation of staff concerned with water supply and waste disposal is essential.

CABIN CLEANLINESS

The state of aircraft interiors is important not only because of appearance but also for reasons of health, and so all cabin, galley, and toilet areas should be tidied and cleaned effectively during each turn round. There must also be suitable arrangements in the galley areas for collection of kitchen waste while in flight.

Control of disease

The speed and convenience of modern air travel, and the vast numbers of people using the facility, make prevention of intercontinental transmission of disease a major undertaking. There is little doubt that air travel has made a tremendous impact on disease patterns throughout the world: in the United Kingdom the continued increase in the yearly incidence of malaria is just one example.[9] The purpose of the WHO International Health Regulations, to which most countries are bound without reservation, is "to ensure the maximum security against the international spread of disease with a minimum interference with world traffic."[10] To this end, articles of the regulations apply to all aircraft and to their ports of entry and exit. The regulations outline the routine preventive and organisational measures to be adopted and describe the wide ranging epidemiological reporting system that allows appropriate steps to be instituted promptly to control any outbreak of disease. The quarantinable diseases of plague, cholera, and yellow fever, and the control of malaria, are governed specifically by the International Health Regulations, but more generally the regulations require that acceptable standards of preventive medicine and hygiene are met. (Regulations governing smallpox were also included until 1981 when the WHO declared the world to be free of smallpox: only Chad still insists on a current smallpox vaccination certificate.) Thus the health administration of each country must ensure that airports have supplies of pure water and wholesome food, for consumption both on the premises and on board aircraft, together with effective sanitation arrangements.

Airports must be free of rodents and mosquitoes and wherever possible sufficient medical and supporting staff should be employed to implement all the regulations. Some airports in each country (the number depends on the volume of international traffic) are designated as "sanitary airports" where, in addition to the usual requirements, there must be an organised medical service with facilities for the transportation, isolation, and care of known or suspected infected passengers. Facilities for disinsecting, disinfection, and other necessary procedures must be available as well as those within the airport or nearby for vaccination against cholera and yellow fever. There must also be a bacteriological laboratory on site or within easy access. Sanitary airports, even when located in endemic areas, are regarded as infection free for the purpose of international travel. Finally, the health administration must designate some airports as having direct transit areas, under the control of health personnel, where passengers en route may be segregated.

Further articles of the International Health Regulations govern health measures to be adopted on departure, en route, and on arrival. It is generally regarded as axiomatic that no person suffering, or suspected of suffering, from any infectious disease may travel on commercial airlines, and indeed this is a requirement of the regulations. The justification for, and logic behind, this all embracing view has been challenged by a medical representative of Air France on the grounds that mistakes or arbitrary judgments may be made and that only a small proportion of infected passengers are known to the airlines before travel: the risk of spread of disease from the large, unknown reservoir of infected people remains.[11] Instead, reliance on normal airline health measures is recommended, and it is suggested that only those passengers suffering from diseases characterised by vomiting or diarrhoea should be refused passage. Nevertheless, the regulations state the need to prevent embarkation of agents of infection or disease vectors on passengers, in baggage, and on aircraft themselves, and most airlines comply with this.

En route, occupants of an aircraft in transit through a country, if disembarked and waiting in a direct transit area, cannot be subjected to any health measure apart from a medical examination. Of course, nothing capable of causing an epidemic disease must be allowed to fall from an aircraft while in flight. On arrival, "free pratique" (that is, permission for an aircraft to disembark passengers and commence unloading/loading) must be given unless there is good reason to suspect that a disease may be introduced or spread. An arriving aircraft and its occupants may, however, be subject to medical examination and any appropriate health measures enforced.

Health conditions on board an arriving aircraft are documented by the pilot, or his authorised deputy, in the health part of the General Aircraft Declaration, which must be surrendered to the airport health authority.

PEST CONTROL

Other regulations lay down the procedures for destroying pests on board aircraft. Disinsecting covers those measures taken to kill insect vectors of human disease. These measures must be applied to any aircraft leaving an endemic malarial area, or other mosquito borne disease area, or an area where insecticide resistant mosquitoes are present or when leaving an infected area en route to an area in which the vector species has been eradicated. The standard of materials (usually synthetic pyrethroid aerosols) to be used is laid down in an annex to the International Health Regulations, and they must, of course, be harmless to humans and to aircraft structures. They must also be efficient and, as with all other health procedures relating to international travel, cause minimum disruption to aircraft occupants and flight operations. Disinsecting may be carried out either well before departure or on arrival, but both of these methods have disadvantages. For example, spraying after arrival is uncomfortable for passengers who may have already been exposed to a live vector during the flight. The method preferred by WHO is to spray the aircraft cabin, external bays, wheels, and freight areas at the last airport before landing in the country which requires the procedure. Single use aerosols are discharged by the crew as near the time of departure as possible—the so called "blocks away" method. Many health authorities insist on the production of the discharged aerosols on arrival as proof of use.

Disinfestation is the term used to describe the methods adopted to deal with other pests. Fumigation at regular (six weekly) intervals keeps cockroaches, the commonest pest of all, in check and is recommended whether or not they have been seen. Rodents, which are quite capable of eating aircraft wiring and other structures, must be destroyed by full fumigation when their presence is suspected on board an aircraft. Hydrogen

cyanide is commonly used and effective but is time consuming and requires very strict safety precautions; authorised contractors must provide a certificate of clearance before re-entry to the aircraft is allowed. Disinfection and deratting procedures will be required on arrival if a person suffering from plague has been on board.

Next week's article covers further aspects of airline operations—aircrew schedules and emergency considerations.

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New Drugs

Anticonvulsant drugs

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A physician now may be understandably uncertain about which anticonvulsant drug to choose from the many available. The older drugs, phenytoin, phenobarbitone, and primidone, may be used wisely with some understanding of their pharmacokinetics, measurement of serum drug concentration, and, when possible, the use of one anticonvulsant only. The choice was extended with the introduction of ethosuximide in the 1950s, diazepam and carbamazepine in the '60s, and clonazepam, valproate, and chlormethiazole in the '70s. In this review the main points in the pharmacology and use of the newer drugs are discussed. The doses and costs are summarised in table I, which includes information regarding the older drugs for comparison. The management of seizures in the neonatal period and early childhood is not considered.

Carbamazepine

Carbamazepine has a tricyclic structure, and like all anticonvulsants the mechanism of action is poorly understood. It now has well established effects in preventing tonic-clonic (grand mal) and partial seizures—for instance, temporal lobe epilepsy—but no effect on absence attacks (petit mal). It is readily absorbed from the gut and is not available for parenteral use. The peak serum concentration occurs four to six hours after a single dose. This is important as peak concentrations may be associated with transient adverse effects. The half life is about 35 hours at the start of treatment, and therefore it takes about seven days—that is, four to five half lives—to reach a steady state on maintenance treatment. As carbamazepine is metabolised in the liver impaired excretion in renal failure is not a problem. Carbamazepine stimulates its own metabolism. In the first four weeks after starting treatment the half life shortens, and the dose needs to be increased to maintain anticonvulsant effects. Thus 100 or 200 mg twice daily may be given at the start and increased at intervals of one to two weeks to a maintenance dose (table I). Some important drug interactions may occur through hepatic metabolism. Serum concentrations of carbamazepine may fall with the introduction of phenytoin or barbiturates, which induce the hepatic enzymes. The induction of liver metabolism by carbamazepine may reduce the efficacy of oral contraceptives and may increase the metabolism of warfarin or dicoumarol.

The plasma protein binding of carbamazepine is 70-80%, less than that for phenytoin and valproate, and it is less prone to displacement by other drugs so that drug interactions on this basis are seldom important. The "therapeutic" or "optimal range" of serum concentrations is quoted as between 25 and 50 μmol/l (6-12 μg/ml) but, as with other anticonvulsant assays, the range should be used only as a guide to treatment. The lower end of this optimal range is poorly defined for seizures may be controlled with serum concentrations below the quoted range, and the dose should not be increased further. The upper level is also poorly defined as some patients may tolerate higher concentrations without adverse effects. Nevertheless, the assays are useful as a guide to treatment if seizures are uncontrolled for lower concentrations may occur from poor compliance or rapid metabolism or the concentration may be adequate indicating a drug failure. Serum concentrations are also useful if multiple drugs are used because drug interactions may produce complex changes. There is a linear increase in serum concentrations with dosage of carbamazepine, in contrast to phenytoin where toxicity may rapidly develop with small increments above the therapeutic range because the metabolism of phenytoin becomes saturated. Some paediatric centres use salivary estimations as these correlate well with the concentration of unbound carbamazepine in the serum.

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