Aviation Medicine

Medical aspects of airline operations

II: Aircrew schedules and emergency considerations

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The need to operate commercial airlines world wide for 24 hours each day inevitably leads to problems of aircrew management: to the stresses of flying an aircraft must be added those of unsocial and irregular hours, time zone (transmeridian), climatic and cultural changes, sleep disturbances, and alterations to circadian rhythms. Fatigue is the main danger, since a decline in performance is likely to accompany it. The economic and operational requirements of an airline must be balanced against these undesirable factors, but good aircrew scheduling is essential to the health, morale, and safety of aircrew: the narrow area wherein lies safe and economic management has concerned the civil aviation industry for many years.

Aircrew scheduling

In 1973 the Bader committee on flight time limitations,¹ while not attributing any aircraft accident in the United Kingdom to fatigue, nevertheless recommended considerable constraints on aircrew scheduling. These constraints, which have recently been updated, clarified, and simplified,² are applied statutorily by the Civil Aviation Authority and include limitations on the maximum flying duty period, minimum rest periods, maximum scheduled duty hours, and minimum cumulative off duty periods. In the United Kingdom proposed flight schedules have to be submitted by the airline management to the Flight Times Limitation Board before their introduction. Other countries have similar limitations, and within such frameworks airlines operate schedules which are further restricted by the need to please passengers and night flying bans, peak hour saturation, and political influences on route planning. In addition, flight time limitations usually reflect conditions acceptable to industrial bodies rather than to medical advisers. The commercial need to keep aircraft flying, and so earning revenue, and the requirements of engineering schedules for airframe and engine inspections and checks are also relevant considerations.

TRANSMERIDIAN TRAVEL

Notwithstanding the commercial bias of present scheduling practice, it is disturbances of sleep and the problems of transmeridian travel that most concern aviation medicine specialists.

Adequate sleep is necessary for aircrew to adapt to irregular work, while alterations in circadian rhythmicity may reduce effectiveness and impair performance.

Aircrew operating long haul schedules alter their sleep patterns to cope with irregular hours and time zone changes by adopting a mixture of short naps and intermediate and long periods of sleep.³ Although there may be some reduction in total sleep time, this pattern appears to be acceptable, but should a cumulative loss of sleep accompany the disturbed sleep pattern the implications for psychomotor performance are more serious.⁴

The endogenous circadian system, in which over 50 physiological and psychological rhythms have now been identified, is known to be affected by many environmental factors including clock hour, light and dark, and temperature, although many of the rhythms continue in the absence of such cues, albeit usually with slightly prolonged periodicity.⁵ The environmental factors facilitate entrainment or phasing of the rhythms and are known as synchronisers or "zeitgebers" (time givers). Travel across time zones outstrips the ability of synchronisers to entrain rhythms and desynchronisation occurs: this is responsible for the syndrome known as jet lag, since circadian rhythms need a finite period to become re-entrained to local time (usually estimated at about one day per time zone crossed).⁶ Westward travel is generally considered to be better tolerated than eastward,⁷ possibly because the endogenous system—with a natural periodicity in most subjects of about 25 hours—is more able to adapt to the longer "day" encountered during westward flight.⁸ The aetiology of the effects of jet lag—sleep disturbances, disruption of other body functions such as feeding and bowel habit, general discomfort, and reduced psychomotor efficiency—has been the subject of much investigation which has largely concentrated on underlying hormonal variations,^{8,9} but for aircrew the important changes are those associated with performance levels.

Ability at many mental skills, including vigilance, choice reaction time, and simulator performance, rises to a peak during the day between noon and 9 pm and then falls to a minimum between 3 am and 6 am. Results of memory tests peak in the morning and then fall steadily.¹⁰ Increased levels of arousal, as a result of flying stress, may partly compensate for decreased performance during troughs in the rhythms and during prolonged periods of work, but if circadian rhythmicity is disrupted by time zone changes then even the usually sound advice to avoid potentially hazardous manoeuvres, such as night take offs and landings, may not prevent reduced flying efficiency and thus flight safety. The rest time required for resynchronisation may be calculated from a knowledge of flight duration and direction, times of departure and arrival, and the number of time zones crossed,¹¹ but aircrew schedules so derived are often commercially impossible to achieve in practice. In the absence of ideal solutions aircrew are recommended to keep sleep deficit

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to a minimum by using any opportunity to take naps.¹⁰ Remaining on home base is also suggested, as is a return home as soon as possible, but such advice is difficult to follow unless the airline scheduling department is aware of these problems and can roster crews to allow them to progress as quickly as possible.

Disturbances in sleep patterns are also a feature of short haul schedules since the times of commuter flights are planned to accommodate the traveller and his normal office hours. Adaptation to the encroachment of schedules on early morning or late evening sleep is achieved by varying the length of sleep at each end of the duty period. Short naps are not a feature of this adaptation and total sleep, over months, for these aircrew is similar to that for non-shift workers.³

CABIN CREW

Finally, while most investigative work in this area has concentrated on the effects on flight deck crew, it must be remembered that cabin staff have a physically demanding job and are subject to similar temporal and environmental stresses. Adequate attention to the scheduling of their workloads is essential especially when cabin attendants are "universally recognised today as the primary cabin safety factor in the event of inflight or ground emergencies."¹²

Emergency considerations

OXYGEN

The oxygen requirements for civil aircraft, both those which are capable of being pressurised and those which fly unpressurised, are laid down in the Air Navigation Order.¹³ For example, aircraft that fly above 35 000 ft (10 668 m) must carry sufficient oxygen for continuous use by the flight deck crew, in the event of depressurisation, as well as an emergency supply for all passengers. This emergency supply must be sufficient for at least 10 minutes' use during a descent to 15 000 ft (4572 m). In addition, a separate therapeutic supply, adequate for two passengers at any one time, must be available. Most airlines comfortably exceed these requirements to avoid problems during testing, due to leakage, and with overseas supply.

FIRE PRECAUTIONS

Clearly, the ideal solution to aircraft fires is to prevent them occurring or, if this is not possible, to extinguish them immediately at source. The use of modern kerosene fuels and fire resistant hydraulic fluids has helped to reduce the likelihood of ignition, while automatic extinguishers in the engines and fuel cut off valves help to prevent spread. But, despite such improvements, 48 cases of fire and 62 instances of fumes and smoke in the cabin in British aircraft were reported in 1978.¹⁴ Toxic fumes, particularly hydrogen cyanide and carbon monoxide, resulting from pyrolysis of cabin furnishings¹⁵ are the greatest single threat to the safety of passengers and crew in an aircraft that has landed successfully with a fire on board. Although excellent, virtually fire proof materials are now available and wide ranging recommendations encourage their use in cabin furniture, expense is often given as the reason for not incorporating them.¹⁴ In a burning aircraft rapid and efficient exit is therefore of paramount importance.

EMERGENCY ESCAPE

In the United Kingdom the Civil Aviation Authority requires that escape from a burning aircraft should be accomplished

within 90 seconds. This standard, however, has been derived from simulated escapes from aircraft that are not on fire, that are not filled with smoke, and in which at least half the exits are available and working correctly. The time limit is helped somewhat by emergency lighting, large doors, and in wide bodied jets double aisles, but the requirement is clearly unrealistic. Furthermore, having reached an exit from which an automatic slide has been successfully deployed, the occupants are still at risk of collision and injury¹⁶—a risk that is clearly increased if the slide fails to deploy, deploys incorrectly, or is destroyed, or if survivors are not quickly led away from the foot of the slide.

Conclusion

We have summarised some of the areas in which the airline/airport doctor might be concerned. The clinical and occupational health and safety of aircrew and of passengers are of obvious importance, but it must be remembered that airlines and airports require an enormous ground based supporting staff. The doctor who chooses to work in this specialty must provide an equally comprehensive service for this population. In addition, there are other medical aspects to be considered in cargo operations including those of dangerous air cargo and, in conjunction with veterinary colleagues, the carriage of animals. The figure shows the scope of the civil aviation medicine specialist.

Scope of civil aviation medicine.

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New Drugs

Non-steroidal analgesic and anti-inflammatory agents

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Population studies suggest that more than 20 million people in the United Kingdom experience some form of "rheumatic complaint" in the course of a year. Eight million consult a general practitioner every year, accounting for 15% of all patients on each practitioner's list and 23% of all consultations. Rightly or (often) wrongly, non-steroidal analgesic anti-inflammatory drugs are prescribed for many of these patients and millions of aspirins, paracetamol, and proprietary compound analgesics are bought over the counter to alleviate headaches, dental pain, and symptoms of all types.

Thirty years ago aspirin and simple analgesics were the only agents available. Today doctors are faced with a bewildering choice of old and new non-steroidal analgesic anti-inflammatory drugs. In the past decade these agents have been developed and marketed faster than any other group of drugs, and the flow of new compounds shows no sign of diminishing. Sadly, the increase in quantity of new preparations available has not been matched by qualitative advances in treatment for patients with rheumatic diseases or by successful radical new approaches to the pharmacological control of pain and inflammation. The proliferation of new agents largely reflects the fact that none is ideal and that the market for new products is large and lucrative. In the main, the newer agents are "me too" molecular variants of older aspirin like drugs. None is appreciably more effective than aspirin in controlling symptoms in patients with inflammatory joint disease, although some are better tolerated and more convenient to take. Rational and clinically useful classification of the newer agents is difficult. Historically, aspirin, phenylbutazone, and indomethacin comprised the first generation of agents, combining moderate efficacy with a high incidence of adverse side effects. During the 1970s a new wave of second generation carboxylic acid

derivatives appeared, which were generally better tolerated but often intrinsically less effective anti-inflammatory agents. In the past three years emphasis has been placed on the added convenience and improved compliance associated with a third generation of agents with longer duration of action, requiring only daily or twice daily dosing.

To a greater or lesser extent all these agents have analgesic, anti-inflammatory, and antipyretic activity. Among a wide range of direct and indirect effects on cellular metabolism they all inhibit the synthesis of prostaglandins at one or more points in the endoperoxide biosynthetic pathways and desensitise blood vessels to the permeability effects of other mediators of inflammation. This inhibition of prostaglandin synthesis is believed to be the basis of both the anti-inflammatory action of these agents and their common propensity to cause gastrointestinal irritation by inhibiting the cytoprotective effect of prostacyclin on gastric mucosa. Recent research has focused on the possibility that some agents may exert their anti-inflammatory effects by inhibiting leucotriene rather than prostaglandin synthesis. Unfortunately, hopes that these would form a fourth generation of safer more effective agents with fewer gastrointestinal side effects have proved to be premature. Indeed, the withdrawal of benoxaprofen after several cases of fatal cholestatic jaundice has emphasised the potential dangers of many drugs with prolonged half lives in elderly patients with impaired renal function. It has also underlined the need for caution in prescribing any new non-steroidal anti-inflammatory drug.

Chemically these agents are carboxylic acid or enolic acid derivatives of several different classes (table). As a group they are weakly acidic, highly protein bound drugs; in general those with a higher pKa have a longer duration of action.

Salicyclic acids

Aspirin is the oldest and cheapest non-steroidal anti-inflammatory drug. In low doses (300-600 mg) it is an effective analgesic and remains the drug of choice for many sorts of pain.

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