**Taking care in the air: Jet Air Travel and Passenger Health, a study of British Overseas Airways Corporation (1940-1974).**

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## Abstract

This paper explores an aspect of medical history that has been overlooked in existing academic studies of commercial air travel, and advances a new historiography of airline passenger health and commercial aviation medicine. The introduction of jet-powered passenger aircraft by British Overseas Airways Corporation (B.O.A.C.) in 1952 presented a new set of epidemiological, chronobiological, and physiological passenger health concerns. These resulted from the increased size, speed, range, and cruising altitude of commercial jet aircraft. Drawing on extensive archival research, this paper explores the nature of these 'new' aeromedical challenges. It places them within the context of much earlier concerns about healthy travel, including military interest in the influence of flight on the human body. Focusing on B.O.A.C., the paper examines the ways in which one major airline responded to the passenger health challenges jet air travel posed, and assesses the extent to which B.O.A.C.'s responses transformed practices of aviation medicine.

**Keywords:** aviation medicine, airline passenger health, commercial aviation, medical history.

## Introduction

On the afternoon of 2nd May 1952, the world's first jet-powered commercial air service, a de Havilland Comet operated by British Overseas Airways Corporation (hereafter B.O.A.C.), took off from London Airport bound for Johannesburg.[1] The Comet's four 5000lb thrust turbojet engines, high-capacity fuel tanks, and heated and pressurised cabin enabled the aircraft to fly 36 passengers at over 450mph (725kph), for 2000 miles (3,200km), at altitudes of up to 42,000ft (12,800m). The Comet immediately reduced the flight time from London to Johannesburg from 32½ hours to 18, enabled Singapore to be reached in 25 hours rather than 2½ days, and cut the flight time to Tokyo from 86 to 33¼ hours.[2] In the words of the then B.O.A.C. chairman, Miles Thomas, the Comet effectively 'shrunk the world to half its former size and…created a new vogue for international travel' which would rapidly transform patterns and practices of human mobility.[3]

The Comet's inaugural commercial service was the result of rapid technological progress that had occurred in the fields of military aircraft design, aerodynamics, material sciences, propulsion, navigation, and avionics both during, and immediately after, the Second World War. After the conflict ended, much of this new aeronautical expertise was transferred to the commercial aviation sector where it enabled the construction of progressively larger, faster, and more sophisticated passenger aircraft. The development, and subsequent utilisation, of a new generation of jet-powered commercial passenger aircraft revolutionised understandings of time and distance and enabled more people to fly to more places more cheaply and more quickly than ever before. Yet, in addition to embodying all that was exciting and progressive about modernity, the physical size and operating characteristics of these new 'jetliners' presented a new and challenging set of

[1] Flight 1952 p.551.
[2] Stroud 1977.
[3] cited in Hensser 1953 p.5.

passenger health concerns which, unlike discourses of military aerospace medicine, social scientists and medical historians have not always drawn attention to.[4] This represents a significant omission. Medical practitioners have long recognised the importance of passenger comfort and the quality of the airborne environment in promoting healthy travel.[5] They have also commented on how predicted growth in passenger numbers combined with an ageing population will exacerbate the medical challenges airlines face.[6] However, no research from within the social or medical sciences has explored the historical relationship between developments in commercial aviation technology and historiographies of airline passenger health.

By way of a corrective, this paper analyses the ways in which commercial jet flight affected passenger health. Our approach is informed by existing studies that have explored the human health implications of different forms of ground and marine transportation, including nineteenth century anxieties surrounding 'railway spine' (a concussion injury of the spinal column which was initially believed to result from vibrations arising from the track) and early twentieth century concerns about the effect of motion sickness and travel fatigue on the occupants of automobiles and ships.[7] We take our cue from the work of Wolfgang Schivelbusch who was one of the first transport historians to consider how the unique kinaesthetic and visual sensations of nineteenth and early twentieth century railway travel affected both the physical and the psychological health of passengers and railway employees.[8] The paper examines the ways in which one pioneer of commercial jet flight, B.O.A.C., responded to the aeromedical implications that the increased size, speed,

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[4] On which see Bushnell 1960; Gibson and Harrison 1984; Hanrahan 1952, 1958; Peyton 1968; and Robinson 1973; and Pascoe 2003; Adey 2010.

[5] See Brundrett 2001; Carruthers et al 1976; Haghighat et al 1999; Hinninghofen and Enck 2006; House of Lords 2000, 2007; Reid et al, 1986, 2006; Richards and Jacobson 1975, 1976; Strøm-Tejsen et al 2008; Sudoł-Szopińska et al 2007; Whittingham 1953, 1955.

[6] Coker and Ingram 2006; Cowling et al 2010; Garoon and Duggan 2008.

[7] Bissell 2009; Caplan 1995; Erichsen 1867; Ferrari 2010; Harrington 2003; Keller and Chappell 1996.Bennett 1928; Desnoes 1926.

[8] Schivelbusch 1977.

range, and cruising altitude of jet aircraft had for passenger health. B.O.A.C. was selected for analysis because; it was the first airline in the world to operate scheduled jet services; it was one of the world's leading international airline brands during the early jet age; and its corporate archives have been preserved.

The empirical material on which the present research is based was obtained from the British Airways Heritage Collection (hereafter BAHC) at London's Heathrow Airport. The BAHC was established in 1974 to preserve the records and artefacts of the newly-formed British Airways and its predecessors, including the interwar Imperial Airways (1924-1939), the original British Airways Ltd (1935-1939), and the post-war operators B.O.A.C. (British Overseas Airways Corporation), BEA (British European Airways), and BSAA (British South American Airways). The archive contains tens of thousands of written records, artefacts, and pieces of corporate ephemera, including passenger information leaflets, minutes of board meetings, and internal briefing documents. Collectively, the archive forms the most comprehensive repository of information that documents the formation, development, and operation of British commercial aviation from the mid-1920s to the present day.[9] All of the material that was consulted was published either solely in English or English with other world languages and was identified by the authors on the basis of content and publication/production date.[10] Sources selected were those that referred to passenger health and/or wellbeing in the air and were published in, or directly related to, the period 1940-1974 when B.O.A.C. was operational.

Although our findings are based on the practices of one international airline, it is not unreasonable to assume that the aeromedical challenges that B.O.A.C. faced were also

[9] While similar repositories of overseas (particularly North American) airline operators exist, e.g. the Pan American archive at the University of Miami, as far as we are aware the BAHC forms the most comprehensive single airline archive in Great Britain.
[10] Other versions initially included French, German, Spanish and Arabic language editions but, later, editions in Mandarin and Japanese were also produced.

experienced by other international airlines that operated jet aircraft. Consequently, our analysis helps to uncover how the technological, regulatory, and practical development of commercial jet air travel from 1952 onwards changed the social history of aviation medicine by introducing a new set of passenger health concerns that had to be addressed to ensure passenger comfort and the continued financial viability of individual airlines.

**Human flight and the development of military aviation medicine**

The origins of aviation medicine as a distinct sub-discipline of medical practice can be traced back to the late-eighteenth century when pioneering hot-air balloonists, or aeronauts, began experiencing strange and unnerving physical symptoms at high altitudes.[11] Subsequent atmospheric research revealed that both temperature and atmospheric pressure fell as altitude increased and this discovery helped to explain why significant elevations in altitude could lead to hypothermia, hypoxia (oxygen starvation), and/or promote a range of uncomfortable or embarrassing sensations as gases trapped in the ears, lungs, sinuses, and intestines of aeronauts, expanded.[12]

While high altitude aerostatic flight presented a number of thermal and physiological challenges to the human body, which could (relatively easily) be overcome through the provision of warm clothing and supplementary oxygen, the advent of heavier-than-air powered flight in 1903 introduced an additional set of aeromedical concerns. Powered aircraft could fly faster, accelerate quicker, ascend more rapidly, and turn more sharply than hot air balloons and, as a consequence, pilots began encountering debilitating physical sensations and psychological anxieties associated with acceleration, deceleration, spatial (dis)orientation, and g-force. Open cockpits exposed pilots to extremes of temperature and weather, and the noise, vibration, and exhaust fumes

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[11] Armstrong 1939; Hartwig 1886.
[12] Howard 1977.

produced by the (usually nose-mounted) engine were considerable.[13] Yet despite awareness from within the aeronautical community that flying had the potential to harm human health, it was not until the outbreak of World War One in August 1914 that dedicated national and independent aeromedical research institutions began to be established.[14]

In Great Britain, a medical division of the British Air Board Research Committee was established in 1917 to coordinate aeromedical research activities, while in the United States, a dedicated School of Aerospace Medicine was founded in January 1918. Like equivalent aeromedical establishments in France, Germany, Italy, the Netherlands, and (later) the Soviet Union, the British and the American institutions conducted systematic scientific investigations into the medical effects of flight on the human body with the aim of improving the physical and cognitive performance of flight crew.[15] Though initially operating largely independently of one another, the research that was undertaken in these laboratories resulted in the development of new technologies and procedures that would help to protect military pilots from harm and enable them to exceed the thresholds imposed by physiological constraints.[16] However, while much was being done to support the development of military aviation medicine during, and immediately after, World War One, the development of regular commercial air services during the 1920s and 1930s introduced a new set of aeromedical challenges.

Unlike military pilots, who were selected, trained, and equipped to withstand extremes of g-force, temperature, and altitude, commercial airlines made flight available to any potential passenger, irrespective of age, gender, or physical fitness, who could afford the

[13] Anderson 1919; Wells 1916.
[14] Gibson and Harrison 2005a; Lavernhe 2003.
[15] Gibson and Harrison 2005a; Peyton 1968.
[16] See Gibson and Harrison 1984, 2005a, 2005b; Harsch 2000; Jones 2008; Kehrt 2006; Lavernhe, 2003; Peyton 1968; West 1998; Wilmer 1979.

price of a ticket. A number of leading aviators, including Britain's Sir Alan Cobham, expressed doubts about ability of 'vulnerable' passengers, including infants, the elderly, and the infirm, to withstand the rigors of flight and to adjust to sudden changes in climatic conditions between their point of embarkation and destination.[17] Medics and clinicians, meanwhile, articulated concern about the potential for air travellers to unwittingly transport infectious diseases around the world.[18]

The outbreak of World War Two in 1939 temporarily disrupted the development of commercial aviation. The conflict stimulated rapid advances in military aircraft design, propulsion, and production methods which would ultimately transform post-war aviation. The development of the gas turbine (or 'jet') engine, which occurred independently in Great Britain and Germany during the 1930s, enabled the construction of new jet-powered military aircraft that could accelerate more quickly, fly faster, fly higher, and outmanoeuvre all existing aircraft. However, while jet flight enhanced the performance of military aircraft, it also imposed a number of significant physiological demands on the human body and new equipment, including g-suits, free flow oxygen systems, and pressurised flightdecks, were developed in an effort to overcome them.[19] After 1945, a number of leading aeromedical scientists in Germany were encouraged to move to the United States and share their expertise. However, even after the war, the global research agenda for aviation medicine remained firmly rooted in the discipline of military aero- and astronautics and the effects of flying on commercial airline passengers did not (at least initially) receive equivalent attention.

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[17] Cobham 1926.

[18] In response, a set of internationally binding sanitary regulations were developed to combat this threat, including the 1929 Parisian Congress on Sanitary Aviation and the 1933 Sanitary Convention for Aerial Navigation, the latter of which addressed the threats posed by Cholera, Plague, Smallpox, Typhus, and Yellow Fever (see Budd et al. 2009).

[19] Gibson and Harrison 2005b, 2005c.

By 1946, civil flying had resumed in Great Britain and the country's international airline, B.O.A.C., which had begun operations in April 1940, was seeking to quickly re-establish the global network of long-haul air services that had been operated by its predecessor, Imperial Airways, between the World Wars. However, the fleet of aircraft that B.O.A.C. inherited, which primarily consisted of decommissioned military transport aircraft, was ill-suited to the demands of passenger flight and new equipment was urgently required.

**B.O.A.C. 'takes good care of you': passenger health in the commercial jet age**

In 1947, the British Ministry of Supply engaged leading British aerospace manufacturer, de Havilland, to design a new jet-powered commercial aircraft. The airframe was intended to simultaneously revive Britain's post-war aircraft manufacturing industry and make a bold statement about the country's aeronautical and technological capability. The resulting Comet D.H.106 first flew in 1949 and quickly revolutionised the patterns and practices of passenger flight. Unlike the existing piston and propeller-engine aircraft, which typically cruised at speeds of 140-200mph and altitudes of 8,000-15,000ft, the economics of jet engine operation dictated that the Comet was most fuel efficient (and therefore cheapest to operate) at speeds of 450mph and altitudes of 35,000ft or higher where the outside air temperature could drop as low as -60$^{o}$C and there was insufficient oxygen to support human life.

As a consequence, de Havilland developed a sophisticated life support system which used 'bleed air' (which had bypassed the engines' central combustion chambers) to artificially pressurise, oxygenate, warm, and humidify the air in the passenger cabin so that its occupants could breathe without the use of oxygen masks and enjoy a comfortable 'shirt sleeve' environment.[20] Using this system, the aircraft's internal cabin environment was artificially pressurised and stabilised at an atmospheric pressure and oxygen concentration equivalent to around 8,000ft.

However, while the system enabled passengers and crew to breathe unaided, it also subjected the aircraft's fuselage to unprecedented pressure differentials between the internal cabin environment and the atmosphere outside. Despite rigorous testing, several Comets were destroyed during flight by metal fatigue which caused catastrophic in-flight decompression, structural failure, and human fatalities.[21] The development of new manufacturing techniques, the use of stronger aluminium alloys, and the introduction of routine structural inspections, reduced the risk of metal fatigue in subsequent aircraft, and the technique of pressurising the passenger cabin using bleed air remained. Given public concern about the safety of the Comet's airframe and the techniques of cabin pressurisation, B.O.A.C. was keen to reassure potential passengers that far from being an alien, dangerous, or uncomfortable form of travel, jet flight represented a superior means of aerial locomotion which was eminently preferable to all other modes of transport:

> 'Jetflight is different... [it is] so quiet, you can chat low-voiced across the aisle. So smooth, you can balance a cigarette on end or build a house of cards'[22]

B.O.A.C.'s marketing rhetoric, combined with the cultural allure of jet aircraft, evidently appealed to wealthy members of post-war British society and, despite lingering concerns about the safety of Comet airframes, the promise of swift and comfortable air travel stimulated unprecedented consumer demand for flight.[23] In recognition that many of

[20] Although the Comet was not the first pressurised aircraft to enter commercial passenger service, it was the first purpose-built commercial aircraft to feature the technology (Boeing's Stratocruiser, which was used on passenger services in North America the 1940s, was a military airframe that had been converted for commercial use).
[21] Bergin 1959.
[22] B.O.A.C. advertisement 1953, BAHC.
[23] See Adey 2010; Pascoe, 2003; Woodley 2004.

B.O.A.C.'s passengers were first time flyers, domiciled in Britain or the overseas territories, who knew little about aviation and who may never have flown before, the airline adopted a duty of care towards them. Under the slogan *'B.O.A.C. takes good care of you'*, the airline began publishing a range of English-language (and, later, multi-lingual) passenger information guides that contained 'jet age' advice about what to pack, how to navigate through a modern airport, how to stay comfortable during a flight, and how to avoid being taken ill whilst overseas.[24] Initially, these contained generic advice about staying healthy abroad, and it was not until the introduction of jet aircraft in the 1950s that explicit advice about staying healthy during a flight also began to appear.[25] In recognition that customer health and in-flight comfort was a vital component in ensuring continued consumer demand for air travel, the airline's Medical Division began contributing health advice for publication in the airline's illustrated 'jet age' passenger information guides *'Before you take off'* (1952) and '*Bon Voyage'* (1953)[26]. Both publications were sent to passengers with their air tickets and disseminated advice about the levels of in-flight service and various physical sensations, such as ear popping, which may be encountered at different stages of a flight.

The introduction of larger and more fuel-efficient jet aircraft, in the form of the 163-seat Boeing 707s, into B.O.A.C. service in 1960, combined with commercial imperatives to maximise the amount of revenue generated per flight, changed the nature of air travel.

[24] B.O.A.C. 1954, 1956, 1959.

[25] See, for example, B.O.A.C. 1940, 1945, 1946a, 1946b, which advised customers travelling to hot climates to seek shade during the heat of the day, avoid eating raw food, apply insect repellent, and take appropriate forms of chemoprophylaxis (B.O.A.C. 1946a).

[26] B.O.A.C.'s medical division was established in 1943 to safeguard the health of the company's pilots and navigators during the war. After 1945, the Division's scope broadened to include both employee and passenger health (B.O.A.C. 1952, 1953).

In common with other operators, B.O.A.C. reduced the amount of space that was available to individual passengers in order to maximise the seating capacity of their aircraft. Whereas First Class Comet passengers had enjoyed 48-inches of leg room, First Class passengers travelling on the B707 found that the space that was available to them had shrunk to 42 inches. The 97 economy (or 'coach') class passengers at the rear of the cabin, in comparison, had to make do with 34 inches.[27] Despite such quantifiable reductions in personal space, B.O.A.C. was keen to reassure customers that their comfort would not be adversely affected and promised that the new seats, although closer together, provided 'better support, deeper cushioning, [and an] improved sleeping position'.[28] However, as later sections of this paper show, higher seating densities and the concomitant reduction in personal space had a number of unintended consequences for passenger health which the airline was, understandably, less keen to publicise.

## Health implications of commercial jet aircraft

While much of the existing literature on air transport history theorises the development of commercial aviation as one of constant progression, acceleration, and geographic specialisation in which newer, more sophisticated airframes progressively replaced older and slower machines, this technologically-determinist discourse arguably masks the subtle complexities of movement and the human health implications of ever faster transit. While surviving historical records show that B.O.A.C. did explore the potential health impacts of air travel on flying personnel, including pilots, radio operators, navigators, flight engineers, and cabin crew from the early 1940s onwards, the health implications for paying passengers did not, initially, receive equivalent attention.[29] The tacit assumption appeared to be that as passengers did not fly as regularly as aircrew, any harmful or unpleasant

[27] B.O.A.C. 1960.
[28] B.O.A.C. 1961.
[29] Bateman and Preston 1970; Bergin 1961; B.O.A.C. 1946a, 1946b; Turner 1968.

health effects would only be temporary and would not have a lasting impact on passengers' physical or psychological health. In the discussion that follows, we identify four distinctive characteristics of jet flight – the increased size, speed, range, and altitude of jet aircraft – and, using archival material from the BAHC, we show how they created new passenger health concerns which transformed practices of commercial aviation medicine.[30]

One of the most striking features of the early jet age was the rapid increase in the size and passenger capacity of jet aircraft. In the 20-year period between the first flights of the Comet, in 1949, and the B747-100, in 1969, passenger capacity increased from 36 to 452, and the length, width, and height of aircraft almost doubled (Table 1).

Table 1: Comparison of the operating characteristics of selected B.O.A.C. jet aircraft

| | Comet 1 | Boeing 707 | Boeing 747-100 |
|---|---|---|---|
| First flight | 1949 | 1954 | 1969 |
| Service entry | 1952 | 1958 | 1970 |
| Passenger capacity | 36 | 189 | 452 |
| Length | 28.61m | 46.61m | 70.66m |
| Wingspan | 34.98m | 44.42m | 59.64m |
| Height | 8.99m | 12.93m | 19.33m |
| Max. take-off weight | 47,620kg | 149,118kg | 333,400kg |
| Max. cruise speed | 725kph | 1,010kph | 970kph |
| Range (max. fuel) | 2,415km | 8,690km | 8,560km |

[30] While we focus our analysis on four selected aspects of jet age flight, we acknowledge that the introduction of jet aircraft introduced other health issues, including increasing exposure to 'foreign' diseases, noise-induced sleep disruption around airports, and respiratory problems relating to engine emissions.

B.O.A.C. introduced their 362-seat Boeing 747-100 ‘Jumbo Jet’ on transatlantic services in 1971.[31] The aircraft’s cavernous passenger cabin, with its two parallel aisles, was subdivided into sections to provide a more ‘intimate’ feel and magazine racks, wardrobes, iced water fountains, and ‘bottle warming bars’ for babies were provided for the comfort of passengers. Yet, despite such provisions, B.O.A.C.’s medical division expressed concern that the presence of large numbers of passengers, all of whom were breathing the same pre-conditioned air, drinking from the same potable water supply, eating similar meals, touching the same surfaces, sharing a limited number of sanitary facilities, and sitting immobile in their seats for many hours at a time, increased the risk of disease transmission and ill health. In response, the airline’s medical personnel recommended that cabin air filtration systems should be installed, protocols to safeguard in-flight hygiene devised and implemented, and written advice be introduced that outlined the steps individual passengers could take to safeguard their health and wellbeing while in the air.[32]

Paralleling the increase in the size of commercial jet aircraft was an increase in the maximum speed at which they could fly. Increased airspeed, though reducing journey times for travellers, had a number of unintended consequences for human health. While jet aircraft accelerated the phenomenon of ‘time space compression’ that had been occurring since the era of the horse-drawn carriage, they also created a new chronobiological condition in which passengers’ circadian rhythms were disrupted. [33] Although pioneering European airlines had been flying long-haul services to outposts of their global Empire since the late 1920s, the limited range of the early aircraft meant that pilots had to

[31] Woodley 2004.
[32] As a consequence, B.O.A.C. undertook regular hygiene inspections of all their catering establishments and reassured potential passengers that the UK’s high hygiene standards were enforced at all overseas airports. Cabin crew were trained to recognise symptoms of infectious disease and were trained to respond (as discreetly as possible so as not to frighten other passengers) to outbreaks of infection. This included rapidly disinfecting surfaces that could have been contaminated, isolating lavatories for the sole use of ill passengers, and administering pain killers and rehydrating fluids to affected travellers.
[33] Janelle 1969.

frequently land to refuel and allow passengers and crew time to rest.[34] Jet aircraft removed the need for these intermediate stops and their superior speed made long-haul trans-longitudinal flights of 8-hours' or more duration a reality. Crucially (and quite unlike military pilots whose sorties were generally short and who typically returned to the airbase from which they had departed), the very point of commercial air travel was to fly, in the shortest possible time, to distant destinations overseas.

Many passengers discovered that trans-longitudinal travel played havoc with their internal body clocks. East-west and west-east flights, involving rapid transit through several time zones, upset the balance between extrinsic time and physiological time and resulted in fatigue, sickness, and disorientation. Passengers experiencing any or all of these symptoms after a long-haul flight were said to be suffering from 'jet lag'.[35] In recognition that the condition had the potential to adversely affect the physical and cognitive performance of both airline personnel and passengers, B.O.A.C.'s Medical Division ensured that the airline's flying staff were given sufficient time to rest between flights and, from the early-1960s onwards, also began offering advice as to how passengers might alleviate some of the worst symptoms. This advice was communicated through a dedicated 'health hints' section that was printed at the back of the airline's in-flight magazine and which recommended that travellers take adequate rest and avoid taking important business decisions within 48 hours of arrival in a new time zone.[36]

In addition to increasing the size and speed of their aircraft, airframe manufactures sought to increase the operating range of their aircraft to remove the need to make intermediate

[34] See Pirie 2010 and Sampson 1984 .
[35] Hauty and Adams 1966a, 1966b, 1966c; Turner 1968. The introduction of supersonic Concorde services by B.O.A.C.'s corporate successor, British Airways, in 1976, took the compression of time and space to new extremes. Cruising at Mach 2.2 (over twice the speed of sound), Concorde enabled passengers to 'arrive' in New York before they had departed from London (as the three hour flight time across the Atlantic was less than the time difference between the two cities) and watch the sun set twice in 24-hours (firstly on departure from London and then again on arrival in New York). Far from being perceived as a problem, however, the chronobiological disjunction Concorde created was promoted as an asset that enabled travellers to 'save time' by being in two places at once.
[36] B.O.A.C. 1968a.

refuelling stops on long haul flights. The resulting improved range of passenger jets enabled ever greater distances to be covered during the course of a single journey and they allowed airlines to inaugurate non-stop direct services between ever more distant airports. However, while the aircraft were able to perform such flights, concern was expressed as early as the mid-1950s that longer flight times, coupled with substantial periods of seated immobility, could promote the development of potentially serious circulatory problems and/or oedema in passengers' lower limbs.[37] While explicit references to incidents of Deep Vein Thromboses (DVT), that were directly attributable to commercial aviation, did not appear until the mid-1990s, a B.O.A.C. passenger information leaflet from 1968 did warn that 'a few passengers on long flights tend to develop swelling of the feet and ankles after sitting for long periods'.[38] In order to prevent such problems, and 'to relieve any discomfort' that did arise, passengers were advised, through a combination of pre-flight and in-flight literature, to 'bend and stretch the ankles at regular intervals on each sector of the flight [and] use the opportunity at transit stops of exercising the muscles of the legs by walking'.[39]

In recognition that many passengers would, despite such recommendations, spend the vast majority of a flight strapped into their seat, B.O.A.C. invested in designing new aircraft seats that would reduce the physical discomforts and lessen risks to passenger health.[40] By early 1960s, aircraft seats had evolved from the purely functional constructions of the 1930s and 1940s into increasingly sophisticated ergonomically-designed structures.[41] B.O.A.C., in common with their competitors, strove to offer their passengers the most luxurious and comfortable seats available. Passengers flying to destinations in Africa and the Middle East, for example, were invited to sample the 'remarkable $350,000 medically

[37] Homans 1954; Leeds 1959.
[38] B.O.A.C. 1968b.
[39] B.O.A.C. 1968b.
[40] Mason 1965.
[41] Eisenbrand 2004.

tested, scientifically cushioned, extra-leg-room totally new level of sinfully luxurious economy-class seat' that was available as standard in B.O.A.C.'s VC-10 fleet.[42]

However, despite sustained investment, ergonomic innovation, and medical intervention, many B.O.A.C. passengers continued to complain about the lack of space and the associated discomfort they experienced during long flights. A letter published in the British Medical Journal in 1953 went as far to enquire whether it had been

> 'brought to the notice of B.O.A.C. that most passengers are quite unable to rest in comfort in the position allowed, and sleep is quite impossible except in very short snatches? I and many friends of average statue have found that after a journey there is such severe oedema of feet and legs that to walk and work in comfort is impossible for several days. Were a little extra space given on the longer runs, with tilted seating and leg rests…passengers could rest and arrive refreshed even when no night stops are made'.[43]

The issue of rest and relaxation was particularly acute for passengers undertaking long-haul trans-longitudinal flights of four or more hours' duration. In order to promote a restful cabin environment and facilitate sleep, B.O.A.C.'s jet aircraft were fitted with soundproofing insulation to deaden the noise and vibration from the engines, and blankets, eyeshades, earplugs, and pillows were carried for the comfort and convenience of passengers.[44] Unlike the Comet and the Boeing 707 and 747s, whose engines were positioned beneath the wings, the rear-mounted engines of the VC-10 meant that the passenger cabin was largely free from engine noise and vibration. Consequently, B.O.A.C. promoted the VC-10 as being 'triumphantly swift, silent, and serene' and 'superlatively

[42] B.O.A.C. advertisement 1965, BAHC.
[43] Letter to the British Medical Journal by Dr. F A Thomson 02/05/1953.
[44] Barfield 1965.

comfortable jetliners' that represented the 'world's most comfortable way to fly'.[45] Potential passengers were invited to eschew the aural and kinaesthetic discomforts associated with the older aircraft that were operated by B.O.A.C.'s competitors and 'try a little VC-10erness' aboard the new jet.[46] While it could be argued that some of the problems associated with rest and relaxation that B.O.A.C. sought to alleviate related more to issues of passenger comfort than passenger health, minutes of B.O.A.C. board meetings suggest that the airline considered the two to be intrinsically interrelated, as it was recognised that passenger discomfort could promote a range of potentially serious health conditions, including thromboses, muscle cramps, and oedema.[47]

In addition to attempting to prevent (or at least delaying the start of) immediate physical discomfort of flying, B.O.A.C. had to contend with other, less obvious and immediate, threats to passenger health and wellbeing. These less tangible threats resulted from the higher altitudes at which jet aircraft flew. In order to maintain an internal cabin pressure equivalent to 8,000ft above sea level when cruising at altitudes of 30,000ft and higher, it was necessary to force compressed air from the engines into the passenger cabin. While the use of 'bleed air' enabled passengers to breathe unaided, any failure in the cabin air supply could be catastrophic as the effects of hypoxia at 30,000ft could manifest themselves after several seconds and humans could be incapacitated in under a minute. As a result, an emergency oxygen supply was installed in the cabin. Any failure in the cabin air supply would cause individual oxygen masks to be deployed from the panel above the passengers' heads. This system would supply enough oxygen to sustain consciousness until the aircraft was able to descend to a lower altitude where passengers could breathe unaided.

[45] B.O.A.C. marketing literature, various dates, 1964-1969, BAHC.
[46] B.O.A.C. marketing literature 1964, BAHC.
[47] Minutes of the Board of the B.O.A.C. Medical Division, 1963, 1967, BAHC.

Although an internal cabin pressure equivalent to 8000ft was adequate for fit and healthy passengers, elderly or very young travellers, or patients with chronic cardio-respiratory conditions, found that the relative lack of oxygen could be problematic, and lead to breathing difficulties, chronic headaches, and feelings of pain or 'fullness' in the inner ear and sinuses. In response, all B.O.A.C. aircraft carried medical bags which contained aspirin and other analgesic preparations and basic first aid kit and cabin crew were able to deliver supplementary oxygen to passengers if they needed it. One of the most frequent causes of discomfort, pain in the inner ear and sinuses, usually occurred during takeoff and/or landing when changes in barometric pressure were most pronounced. B.O.A.C. advised passengers that:

> 'The alteration in pressure when the aircraft is landing may temporarily affect your ears but you will find that swallowing, pinching the nostrils and blowing, or sucking a sweet will relieve most of the discomfort. If you suffer from sinus trouble or have a heavy cold you may need the additional help of an inhalant. Please ask the Stewardess for an inhaler…Babies can be given a dummy to suck and should not be discouraged from crying at this time as this is nature's way of assisting them to clear their ears'.[48]

Concern was also expressed that changes in cabin pressure might cause problems for passengers who had undergone abdominal or dental surgery within the previous four weeks or for individuals who had 'delicate' digestive systems. B.O.A.C. advised passengers to refrain from flying within a month of certain surgical procedures, such as hernia repair operations, and warned that abdominal distension and/or flatulence were relatively common side effects of flying.[49] In order to reduce the potential discomfort to individual passengers and preserve 'fresh' air in the cabin, B.O.A.C. advised travellers to

[48] B.O.A.C. 'Bon Voyage', passenger information leaflet, 1952.
[49] Turner 1968; Howard 1977.

avoid consuming large meals or carbonated drinks immediately before or during a flight and suggested that eating small quantities of food more regularly would help avoid feelings of digestive ‘sluggishness’ and bloating.[50]

A further potential health problem that related to the altitude at which jet aircraft flew concerned the temperature and the dryness of the air that was supplied to the cabin. At an altitude of 35,000ft the atmosphere is not only less dense, but the air is also considerably colder and drier than that at ground level. Consequently, the bleed air from the engines was passed through air conditioning packs where it was filtered, warmed, and humidified before being supplied to the passenger cabin. Nevertheless, the air remained appreciably drier than ‘normal’ air and, to combat dehydration, which was reportedly a leading cause of passenger discomfort, B.O.A.C. installed cabin air humidifiers and advised passengers to drink plenty of water and fruit juice, avoid caffeinated, carbonated, or alcoholic drinks, regularly moisturise their skin and lips to prevent cracking, and wear conventional spectacles in preference to contact lenses.

The volatile price of crude oil in the late 1960s and 1970s prompted many airlines, including B.O.A.C., to progressively reduce the volume of bleed air that was taken from the engines and increase the quantity of air that was recycled around the cabin. While this reduced the airline’s fuel costs, it also had the effect of increasing the risk of disease transmission between passengers owing to the presence of re-circulated air. While air filtration packs removed many pathogens and particulates, they were unable to remove engine fumes which could, on occasion, contaminate the cabin air supply.[51]

[50] B.O.A.C. in-flight magazines, various dates, 1968-1972, BAHC.
[51] While we found no reference to concerns about cabin air quality in the material we consulted, recent research (Seabridge and Morgan 2010) indicates that it could be a serious public health concern.

## Conclusion

In documenting the changes in aeromedical practice, from their origins in the eighteenth century to the early-1970s, this paper has explored an aspect of aeronautical and medical history that has received relatively little attention in the academic literature to date. It has shown how the development of a new form of aerial propulsion and its subsequent utilisation on commercial aircraft, exposed passengers to a new and challenging set of health concerns. By identifying four characteristics of jet age flight, and exploring how they impacted on the health and wellbeing of B.O.A.C. passengers, the paper has explored how the sudden increases in size, speed, range, and altitude of jet aircraft not only introduced a new set of medical challenges for airlines but also impacted on commercial airline practice and discourses of aviation medicine. Whilst our research has focused on the experiences of a single (albeit major) international airline, we have shown how growing awareness of the aeromedical implications of jet flight on passenger health led to the provision of in-flight health advice.

Despite such interventions, however, B.O.A.C. had only a limited capacity to influence passenger behaviour. Indeed, while the airline sought to empower their passengers to ‘take good care of themselves’ through the provision of in-flight health advice, the company could neither enforce appropriate behaviour nor eliminate all risks. As we have shown, higher capacity aircraft, whilst lowering the monetary cost of air tickets, increased the risk of disease transmission between passengers; rapid trans-longitudinal travel resulted in a new chronobiological condition of ‘jet lag’; longer flight times raised concerns about immobility, venous embolism, and food hygiene; prolonged high-altitude flight heightened the risk of dehydration; and changes in barometric pressure could cause ear and sinus pain.[52] In addition, flight exposed passengers and crew to ionizing radiation and higher levels of atmospheric ozone. However, as relatively little was known about the long-term health risks of exposure, and, arguably, the airline did not want to discourage potential customers from flying, no mention was made of these risks in the material we consulted.

This has a number of important consequences for the social history of commercial aviation medicine. In chronicling the evolving patterns and practices of flight and the changing nature of the health advice B.O.A.C. offered, we posit that the coming of the jet age fundamentally altered the relationship between airlines and their customers and changed aeromedical practice. Airlines were dependent on their passengers for revenue and profit, while passengers relied on their airline providing a safe and comfortable service that would not harm their health. Given that the average passenger in the 1950s and 1960s knew relatively little about aviation or its potential health effects, airline operators were obliged to 'take good care of them' by alerting them to potential risks to their health and wellbeing and advising them on the steps that could be taken to reduce the risks that had been identified. However, the decision about which risks to communicate to passenger was, we argue, informed not only by medical knowledge but also influenced by the politics of airline marketing and the need to present jet air travel as a modern, exciting, and safe mode of transport in order to generate and sustain passenger demand. Consequently, the severity of certain (albeit relatively uncommon) health risks associated with flying, such as DVT, although known as early as the mid-1950s, were not explicitly communicated to passengers as the airlines were caught between a moral and a commercial imperative to protect passenger health (and thereby safeguard their reputation) on the one hand and a financial imperative to protect the company's profit on the other. In addition to discussing

[52] However, despite extensive searches, we were unable to locate any statistical evidence from the BAHC which detailed the actual numbers of B.O.A.C. passengers who reported suffering from such complaints.

the aeromedical implications of jet flight on airline passenger health, the paper has sought to highlight how a sub-discipline of aviation medicine - concerned with commercial air travel – which developed in the early jet age, has shaped contemporary understandings of airline passenger health and customer wellbeing in the air.

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