執勤時之睡眠時間

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登載於《航太醫學與人員績效》(Aerospace Medicine and Human Performance)期刊2022年4月號中的此項研究，取樣自2015至2019年期間，於3個長程與5個超長程航線上，「飛航執勤時間」(flight duty period)達1,200小時的231名飛航組員。美華盛頓州立大學之「睡眠與績效研究中心」(Sleep and Performance Research Center)的研究員，從受測者的飛行紀錄與活動紀錄器(actigraphy)上取得所需資料；活動紀錄器外觀類似腕錶，其內建感應器可監測使用者活動，以評估使用者睡眠與清醒之周期。

研究結果顯示，執行8至16小時長程飛航勤務的飛航組員，於航程中平均有3.7小時之睡眠時間；而執行16小時以上超長程勤務之飛航組員，航程中平均睡眠時間則有4.7小時。依據此項研究編寫的報告指出，在某些超長程飛航勤務中，某些組員的睡眠時間可高達8小時。

前述超長程飛航勤務中需要有3至4名組員，其中1或2名為值勤組員(flying crew)，負責從航程開始至爬升頂端，再從下降起始點至抵達登機門期間操作飛機。其餘則擔任輪替組員(relief crew)，於飛機航行期間負責操控飛機。如此之人員配置，可讓負責降落之值勤組員在「飛航執勤時間」後半段，至少能有2小時睡眠時間，以符合《美國聯邦航空法規》(U.S. Federal Aviation Regulations)。

一項研究指出，相較於過去，現在的長程(long-range, LR)與超長程(ultra-long-range, ULR)航線執勤之飛航組員更為依靠「簡單休息作法」，取得更多睡眠時間，且經過驗證後，這項作法之成效更佳。

是項報告指稱：「即使容許飛航組員於勤務期間有機會入睡，要將睡眠時機順利轉變為有效睡眠，尚取決於某些因素。例如，航行中最有效的睡眠時機，是能夠銜接組員自身準備入睡的時間。」

睡眠時機須視飛航組員維持清醒時間長短與其生活作息而定，生活作息就像是大腦中的生理時鐘，在一天24小時中調節睡眠與清醒模式。

研究方法

參與研究的235名航空公司的飛航組員，其中91%為男性，年齡分布於34至64歲之間。某些受測者在研究期間飛行不同航線，另亦有多次飛行相同航線的受測者。所有受測者皆操作波音787型機，機上皆備有與座艙、客艙分離的休息區以隔離噪音，且就寢空間均有溫控，並能讓休息組員控制燈光。

研究取樣之航線如下：從舊金山、洛杉磯至新加坡、上海與澳洲雪黎；從洛杉磯至澳洲墨爾本；從洛杉磯至上海；從舊金山至中國大陸成都，以及從德州休斯頓至雪黎。

研究中檢視時間長短與時機不同，以及個別或結合其他休息等 8 種類型之休息時段。

受測者調查之分析結果顯示，值勤組員採取「後半休息」(second break) 作法，即在勤務後半段中採長時休息一次，而輪值組員採取「前半休息」(first break) 作法，即勤務前半段中採長時休息一次，以前述搭配作法的組員在長程飛航勤務中佔 94%，超長程飛航勤務中則佔 65%。長程飛航勤務的組員並未採取較複雜的「四段休息」(four-break rest) 作法，僅有從休斯頓至雪黎與從加州機場至新加坡在航程最遠的超長程航線上執勤的飛航組員，以及往返前述加州兩機場與雪黎之間中有 2 名輪值組員的航班，曾採「四段休息」作法。

研究人員以睡眠在休息時間所佔比率以計算睡眠成效，發現「後半休息」作法的成效最佳，有 77% 休息時間用於睡眠。其他休息方式睡眠成效區間分布在以下兩種方式之間：其一為組員在勤務後半段分兩次休息，第二次時間較第一次為長的「後半分段」(split second) 休息方式，睡眠成效為 53%；另一為組員在勤務中段採長時休息一次的「中段休息」(middle scheme) 方式，睡眠成效為 75%。

是項研究亦檢視受測飛航組員的飛航勤務期間總睡眠 (total in-flight sleep, TIFS) 時數，並發現長程飛航勤務組員的 TIFS 為 3.7 小時，而超長程飛航勤務組員的 TIFS 則為 4.7 小時，且前述受測者通常採用在飛航勤務中休息一至二次的簡單休息作法，而非休息四次的複雜作法。報告中指出受測期間，在最長程的勤務中僅少數採用複雜的休息作法，且其睡眠成效通常低於簡單休息方式。

報告指出，該研究主旨在於運用科學數據成果，協助研擬建議睡眠作法，並對飛航組員執勤期間實際休息方法的建議進行比較，以及針對特定航線具擬新建議作法。

是項研究藉由比較不同休息方式之睡眠成效，指出採取休息四次的複雜休息作法「的成效低於更為簡單之作法」，這項發現與過去某些研究結論不同。

報告指出，過去某些研究發現超長程與長程飛航勤務組員的睡眠時數低於本次研究結果；例如先前有項研究指出，超長程飛航勤務組員之 TIFS 在 3.5 至 4.1 小時之間，長程飛航勤務組員之 TIFS 則在 3.1 至 3.5 小時之間。報告稱先前研究成果係為推動休息四次方式之決策基礎。

報告寫道：「現在需再重新進行研究，可以納入某些量化方法，俾評估不同研究團體對於睡眠成效與 TIFS 研究成果差異構成之原因。對此現象的一種推測是不同航空公司的企業文化，可能是飛航執勤時間、休息方式、TIFS 與睡眠成效之間的影響因素。蒐集更多資料，並對想像所及的不同因素進行分析，有助於研究人員更廣泛瞭解影響飛航勤務中睡眠與後續表現的關鍵因素。

譯自 Aero Safety World April 2022

Sleepy Times

Simple rest schemes are helping pilots on long flights sleep longer and better, researchers say.

Linda Werfelman

The study, published in the April issue of Aerospace Medicine and Human Performance, was based on data collected between 2015 and 2019 from 231 pilots who flew 1,200 flight duty periods on three LR routes and five ULR routes. The researchers, from the Sleep and Performance Research Center at Washington State University, collected data from logbooks and actigraphy, which involves wearing a wristwatch-like device containing a sensor that monitors an individual's movement and can evaluate sleep-wake cycles.

Pilots on long-range (LR) and ultra-long-range (ULR) routes are relying more on "simple rest schemes" – and getting more sleep – than they did in the past, according to a study that credited the increased efficiency of their rest practices.

The study determined that pilots on LR flights – those of eight to 16 hours – obtained an average of 3.7 hours of sleep while en route, and pilots on ULR flights – those longer than 16 hours – slept an average of 4.7 hours. Some crewmembers obtained as much as eight hours of sleep on some ULR flights, according to a report on the study.

These flights require three to four flight crewmembers, with one or two pilots designated as the "flying crew" and operating the airplane from the start of the flight to the top of climb and again from the top of descent to arrival at a gate. The other pilots, designated as the "relief crew," operate the airplane during cruise flight. The arrangement allows the pilot in the flying crew who will conduct the landing to have an opportunity for at least two hours of sleep in the second half of the flight duty period as required by U.S. Federal Aviation Regulations.

"Even though pilots are allowed in-flight sleep opportunities, there are a number of factors that determine if and how an opportunity for sleep is successfully converted into beneficial sleep," the report said. "For example, the opportunities for in-flight sleep are most successful when they line up with the times the pilot is naturally primed for sleep."

That timing depends on how long a pilot has been awake and on the body's circadian rhythms, which have been described as a sort of biological clock in the brain that regulates patterns of sleep and wakefulness during a 24-hour period.

Study Methods

Of the 235 U.S. airline pilots participating in the study, 91 percent were men, with ages ranging from 34 to 64. Some flew different routes during the course of the study, and others flew the same route multiple times. All flew Boeing 787s, all of which are equipped with a rest area separate from the flight deck and passenger cabin and isolated from noise, have some sort of sleep surface, are temperature-controlled and allow the resting pilot to control the light.

The routes included in the study included those from San Francisco and Los Angeles to Singapore, Shanghai and Sydney, Australia; from Los Angeles to Melbourne, Australia; from Los Angeles to Shanghai; from San Francisco to Chengdu, China; and from Houston, Texas to Sydney.

The study examined eight types of rest breaks that were distinguished by their length, their timing and their use alone or in combination with another break.

An analysis of the survey results showed that on 94 percent of LR flights and 65 percent of ULR flights, the flying crews used the "second break" scheme – taking one long break during the second half of the flight – and relief crews used the "first break" scheme, with one long break during the first half of the flight. Pilots on LR routes did not use the more complex four-break rest schemes; those schemes were used only by pilots on the longest ULR routes – from Houston to Sydney and from the California airports to Singapore – and by two relief crews on flights between the two California airports and Sydney.

In calculating sleep efficiency – the percentage of break time that was spent sleeping – researchers found that the second break scheme was most efficient, with 77 percent of time during those breaks spent asleep. In the other types of rest brakes, sleep efficiency ranged from 53 percent for a "split second" scheme in which a crew takes two breaks, with the second one longer than the first, to 75 percent for a "middle scheme" in which a crew takes one long break in the middle of a flight.

The study also examined the total in-flight sleep (TIFS) for participating pilots and found that, on average, LR flight crews obtained 3.7

hours TIFS and ULR crews obtained 4.7 hours TIFS, typically by using simple rest schemes that involved one or two breaks in a flight duty shift rather than complex schemes that involved four breaks. When implemented, the complex schemes were used only on a few of the longest flights, and they generally resulted in lower sleep efficiency than the simpler schemes, the report said.

The study was intended to help develop sleep recommendations based on scientific findings, compare those recommendations with the ways pilots actually rest during flight and develop new recommendations for specific routes, the report said.

By comparing the various rest schemes for the associated sleep efficiency, the study determined that complex rest schemes that involved four breaks were "less efficient than simpler schemes" – a finding that differed from those of some earlier studies.

Some of those studies found that both ULR pilots and LR pilots obtained less sleep than indicated by this study's findings, the report said, citing one earlier study that reported TIFS values between 3.5 and 4.1 hours for ULR pilots and between 3.1 and 3.3 hours for LR pilots. Those earlier findings were the basis of decisions to offer four-break rest schemes, the report said.

"Replication studies are needed that potentially include some qualitative methods to assess why different research groups report different sleep efficiency and TIFS results," the report said. "One speculative answer to this is that different airlines may have cultures that somehow act as a mediator between flight duty period, rest schemes, TIFS and sleep efficiency. Collecting more data and analyzing with these various factors in mind will help researchers gain a broader understanding of the key factors that affect in-flight sleep and subsequent performance."

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