“JET LAG”: CIRCADIAN RHYTHMS & CROSSING TIME ZONES

1. **1884**, Creation of **International Time Zones**

2. Description of “**Jet Lag**” **Symptoms**

including “mega-laggers”

3. Air Crews

87% report “disturbed sleep”
93% report that “fatigue” is “a problem in their type of flying”
FAA regulations not revised since 1934…
- 8 hrs. domestic flying/24, 12 hrs. international flying/24
- no consideration given to circadian rhythm, e.g. direction of flight
  - e.g. schedule consistency
- no naps permitted

frequent reports of GI disorders, stress, nervousness, insomnia
not data on shorted life-span (animal data does show this)
when do air crew errors happen & why?
- esp. at end of flight (descent, approach, landing)
- estimate that 10% related to “fatigue”
- esp. between 12 midnight and 6am (circadian “danger zone”)

strategies used in Germany, Europe, Israel

4. Circadian Rhythm Disturbance vs. **Effects of High Altitude Flying**

Effects of high altitude flying (35-40K feet, 5% humidity):
low O2 levels, tobacco smoke (CO, tars, particulates), air turbulence, low barometric pressure (= 7K feet), vibration, noise, cramped seating (poor circulation, clot formation), flight anxiety, pre-flight lack of sleep, dehydration (dry, itchy eyes, etc.), irritated nasal passaged, skeletal muscle camps, headaches, nausea, edema, infrequent dizziness (2nd to inner ear disturbances), and increased exposure to ionizing radiation (cosmic-sourced)

5. **Origins of True "Jet Lag" Effects**

these effects outlast the effects of high altitude flying
sources of jet lag effects:

a. external desynchronization
b. internal desynchronization
c. sleep loss

6. **Modifying Factors**

direction of the flight
number of time zones crossed

7. **Individual Differences**

age, sex, basic circadian "style" (lark vs. owl)

8. **Jet Lag Counter Measures (esp. for eastward flight and for a trip of more than a few days)**

a. time of arrival timed to be evening in new time zone, go to bed/ sleep (perhaps with melatonin several hours earlier)
or time arrival close to your usual (home time) bedtime, go to bed/sleep (may not need melatonin), then get up in morning (new time), go outside (need sun exposure to suppress your own melatonin) & stay outside all day/stay physically active
b. shift light/dark conditions and meal times to match those of destination (several days before trip, at least upon entering plane)
c. reset watch to match time at destination
d. take melatonin/benzodiazepine (e.g. Ambien, Sonata) inflight at time to match bedtime at destination (helps *S* get to sleep on plane and begins to reset rhythm)
e. do not drink alcohol (further dehydration), caffeine (further dehydra-tion); do drink lots of water
f. make several overnight stops on the way to final destination (or do not travel by plane)
g. if making a short trip (few days duration) stay on home time (do not go out of doors, stay on home time bedtimes/wake up times)

9. **<u>Travel in Space…The *Ultimate* in "Jet Lag"?</u>**

Back in the early 1990's, Dr. Charles Czeisler (Harvard)

Used bright (10,000 lux) to reset space shuttle crew's circadian rhythms pre-flight so that they were in W (wide awake) at launch time (1am)

As durations of the time in space shuttles increased, evidence of more severe circadian rhythm disturbances have been observed

Note: most space shuttles will orbit the earth every 90 to 100 minutes, with alternating periods of light and dark

Report #1: 200l (Sleep, performance, circadian rhythms, and light-dark cycles during two space shuttle flights)

Tested 5 astronauts before, during & after **16-day** and **10-day** space missions

Results: 1) Endogenous S/W rhythms were **shorter** than 24 hours by about 20-35 minutes

2)Light-dark cycles were quite **variable** in space shuttle, and "daytime" illumination levels were quite **dim** (5.0 to 79.4 lux) inside the shuttle

3)Amplitude of CBT rhythms was reduced

4) Circadian rhythm of urinary cortisol no longer matched the *S's* other rhythms

5) Decrements in behavioral tests

6) **Shortened TST** (to 6.5 hrs/day)

7) Subjectively rated sleep quality was decreased

8)**Increased WASO**, **decreased SWS** (NREM stages 3&4)

9)Giving 0.3mg melatonin on alternative nights --- no effect

10) After return to earth, a large **REM rebound** observed

9. Travel in Space (cont.)

Report #2: 2001 (Astronauts' sleep may get lost in space)
Tested **one astronaut** (Linenger) during a **5 month** stay on Mir in 1997
Reported data on himself during 3 blocks of time: days 37-50, days 79-91, and days 110-122
Took his oral temperature & rated his sense of alertness at the same 5 times during each 24-hour time interval; he went to bed and arose at regular times in each 24-hour interval; recorded amounts and quality of his sleep
Results: 1) After 3 months in space, *S* **lost his circadian rhythms**
2) **Severely disrupted sleep**
3) Pre-space, *S's* CBT was declining as he fell asleep, rising as he awakened; this continued at least for the first 91 days in space
4) Also, during first 91 days in space, *S* reported sleeping well and staying alert while awake
5) By 3rd block of days (days 110 on), S no longer had a daily cycle in his CBT (CBT remained nearly constant whether he slept or was awake); he often did not feel sleepy at his regular bedtime; reported that he was "losing track of each 24-hour day".
6) The TST decreased, his WASO increased

Report #3: **2001** (Space flight dramatically reduces sleep-related disturbances and snoring)
Note: both American and Russian astronauts have very few medications in space, but what they have used are mainly **sleeping pills**!
(45% of all medications used by 219 astronauts in 79 shuttle missions were hypnotics)
Note: Do astronauts have more/less difficulty breathing in space, During sleep in space, During sleep in space while on hypnotics?
Results: 5 astronauts studied all showed **dramatic reductions in number of sleep-related breathing disturbances in space**
55% reduction in AHI (apnea-hypopnea index) 8.3 --- 3.4
"elimination" of snoring (16.5% of TST --- 0.7%)
Thus, gravity must have adverse effect on anatomy re. to respiration