

# Care in the Air

## Preflight Assessment and In-flight Medical Care for the Internist

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General Internal Medicine Grand Rounds

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# Commercial Aviation

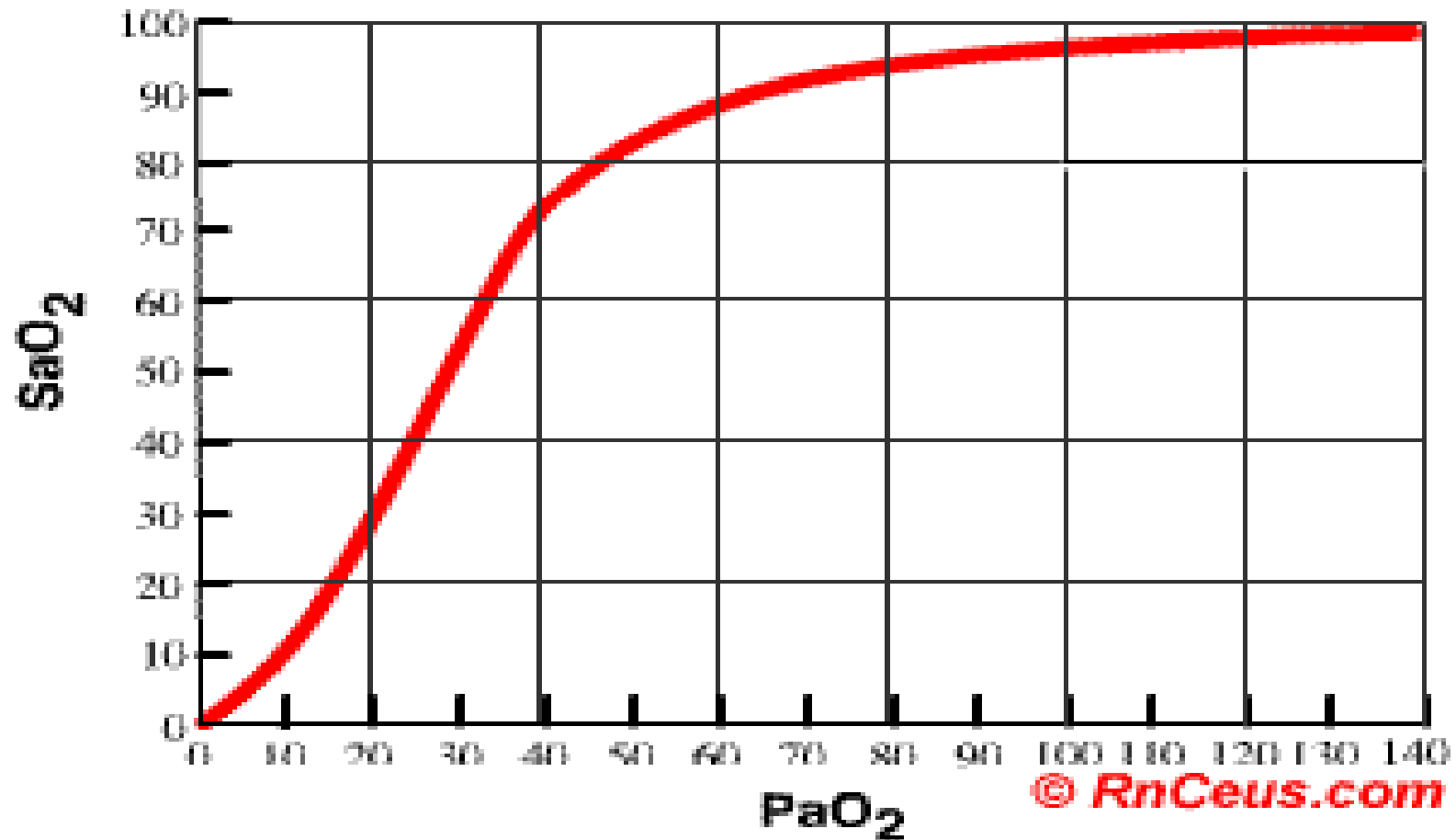
- Almost 2 billion passengers yearly
- Inflight medical emergencies estimated between 20 to 100 per million passengers
  - Death rate estimated 0.1 – 1 per million (approx 20 – 100 passengers in US per year)
  - Medical professional present for 40 – 70%; MD present in up to 60%
  - Severe emergencies have doubled in the last decade

# Commercial Airliners

- Cabin pressurized to maximum of 8000 feet
  - Equivalent to breathing sea level air mixture with  $FiO_2$  of 17%
  - Average  $SaO_2$  drop of 4.4% in healthy subjects
- Humidity between 10 – 20%
- Pre and in-flight stressors exert disproportionate toll on those who suffer from chronic medical illness at baseline

# Hemoglobin Dissociation

## OxyHemoglobin Dissociation Curve



# Case

- 69 y/o woman plans flight from Denver to Frankfurt to visit family
- PMHx: mod – severe COPD (FEV<sub>1</sub> 1.12 – 47% pred) with 2-3 flares/year, tobacco use, HTN
- Uses nocturnal O<sub>2</sub> (2L/min) and occasionally daytime during flares
- Most recent exam: 92% O<sub>2</sub> sat at rest, 90% with moderate exercise
- What advice should she receive to minimize peri-flight health consequences?

# Preflight Assessment

- Air Carrier Access Act (1986): US DOT required to ensure persons with disabilities able to fly without being discriminated against
- Unstable medical conditions should not fly
- Some airlines require passengers with medical condition that could cause in-flight illness, injury, or risk to other passengers to have medical certificate from clinician

# General Preflight Assessment

Patients with significant comorbid illnesses (cardiovascular dz, VTE, RAD, COPD, epilepsy, recent stroke/surgery, diabetes) should carry:

- Detailed medication list
- List of all diagnoses
- Any medications (BD's, insulin, NTG) that may be needed during flight
- Medical alert bracelet for severe allergies/disease
- Copy of recent EKG – especially CV patients

# Preflight Assessment

- Fitness to fly – not objectively validated
  - Walk 50 yards at a normal pace or climb 1 flight of stairs without becoming symptomatic
- More complex medical conditions require additional preflight testing and treatments

# Cardiac Disease

- Uncomplicated MI – no air travel for minimum of 2 weeks afterwards
- Complicated MI – at least 6 weeks afterwards, or 2 weeks after clinically stabilized
- Contraindications to flight:
  - Unstable angina
  - Symptomatic valvular disease
  - NYHA III/IV CHF
  - CABG within previous 3 weeks (longer for any residual postop PTX)
  - Uncontrolled supra/ventricular arrhythmias

# Post-MI

- Randomized, single-blind controlled trial with 38 patients 2 weeks s/p MI
  - Half received O<sub>2</sub> 2L/min throughout flight; all patients wore Holter monitor
  - Major end point – inflight myocardial ischemia
  - Minor end points – CP/dyspnea, bi/trigeminy, desat <90%
- 1 major end point only; 34% had minor end points, but none with Holter evidence of ischemia
- No difference in incidence of minor end points between O<sub>2</sub> and no O<sub>2</sub> groups

# Pacemakers and ICD's

- No evidence that air travel interferes with function
- Airport security may detect pacemakers, ICD's, and stents – card identifying type of device/stent and hand search recommended
  - Should also carry copy of EKG both with and without a magnet
- Theoretical risk alternating magnetic field of handheld wand may be detected by ICD and cause inadvertent shock
  - Request a hand search if possible
  - If wand must be used, examiner should be advised not to hold magnet over the ICD/Pacer for more than a few seconds, and provide at least 30 seconds between each pass

# Neurologic Assessment

- Stroke within 2 weeks a contraindication to air travel
- Epilepsy not a contraindication, but pt's with severe seizures should not fly until better controlled
- Migraines – often triggered by airplane travel
  - Keep rescue medications in carry-on luggage
  - Maintain prophylactic medications (if taking)

# Pregnancy

- No official aviation policy
- ACOG does not recommend air travel for women beyond 36 weeks gestation
- Increased DVT risk
- Premature delivery risk, IUGR, or high-risk pregnancy (placenta previa, preeclampsia) should not fly

# Diabetes

- Modification of insulin dose/timing may be needed
  - Rapid acting insulin, even if not used at baseline, recommended during long flights
  - Eastbound: Day shortened and less long-acting insulin may be needed
  - Westbound: Day lengthened and additional short-acting doses or increased dose of basal insulin may be needed
- Do not put insulin in checked luggage
- Type I advised to carry additional CHO in case of delayed flights or meals
- Keep watch at local (departure) time throughout flight

# Respiratory Disease

- Absolute contraindications
  - Pneumothorax
  - Bronchogenic cyst
  - Severe Pulmonary HTN (NYHA III/IV)
- Severe respiratory compromise possible from even small degree of hypoxia aboard airliner
  - Increased minute ventilation can exhaust already reduced ventilatory reserve
  - Pulmonary vasoconstriction paradoxically causes V/Q mismatch, increases dead space, and worsens hypoxia

# Respiratory Disease

- Cystic fibrosis/bronchiectasis
  - Carry-on antibiotics and secretion clearing medications
  - Aggressive in-flight hydration and O<sub>2</sub> if indicated
- Asthma
  - Uncontrolled or s/p recent hospitalization should not fly
  - Controlled OK for flight, but carry  $\beta_2$ -agonist and oral steroids on board
- OSA
  - Avoid EtOH and sedatives before/during flight
  - CPAP users advised to bring unit to use in flight

# COPD

- Particularly susceptible to in-flight respiratory insufficiency
  - Up to 33% of COPD pt's develop  $\text{PaO}_2 < 50$  mm Hg at 8000'
  - Normoxic COPD patients breathing hypoxic gas mix desaturated to mean 86% with exertional desat to 78%
- Higher VTE risk
- All COPD patients recommended to undergo clinical and functional evaluation of fitness for flight

# Hypoxemia Evaluation

- 50 meter walk widely used by airline companies
  - Inability to finish or severe dyspnea indicate need for clinical and functional assessment, and possible need for in flight O<sub>2</sub>
- 6-minute walking test – standardized, validated, used in most PFT labs
- Hypoxia altitude simulation test (HAST)
  - 15% O<sub>2</sub> & 85% N<sub>2</sub>, continual pulse oximetry and EKG monitoring; occasionally PaO<sub>2</sub>
  - 20 minutes, or until pulse ox stabilizes
  - Pulse ox <85% or SaO<sub>2</sub> < 50 indicate risk for in-flight hypoxia

# Hypoxemia Evaluation

- HAST considered gold standard, but not performed at many hospitals or PFT labs
- Baseline pulse ox and 6-minute walk more practical for pre-flight assessment
- Preflight sat > 95% - no contraindication to flight
- Preflight sat <92% - in-flight O<sub>2</sub> recommended
- Preflight sat 92 – 95% - HAST (if available) or 6 minute walk recommended
  - In flight O<sub>2</sub> for sat <85% or PaO<sub>2</sub> <50 during testing

# In-flight Oxygen

- FAA prohibits pt's from carrying their own O<sub>2</sub> tanks or liquid oxygen aboard
- Airlines will supply O<sub>2</sub>, but require advance notice (between 48 hrs and 10 days)
- Portable O<sub>2</sub> concentrators with up to 3L/min continuous or 6L/min pulsed flow
  - Patients need to provide batteries to power – recommended enough 12 cell batteries for 1.5x anticipated flight duration
- Clinician letter specifying underlying condition, prescribed liter flow, and whether supplemental O<sub>2</sub> required just during flight or all day

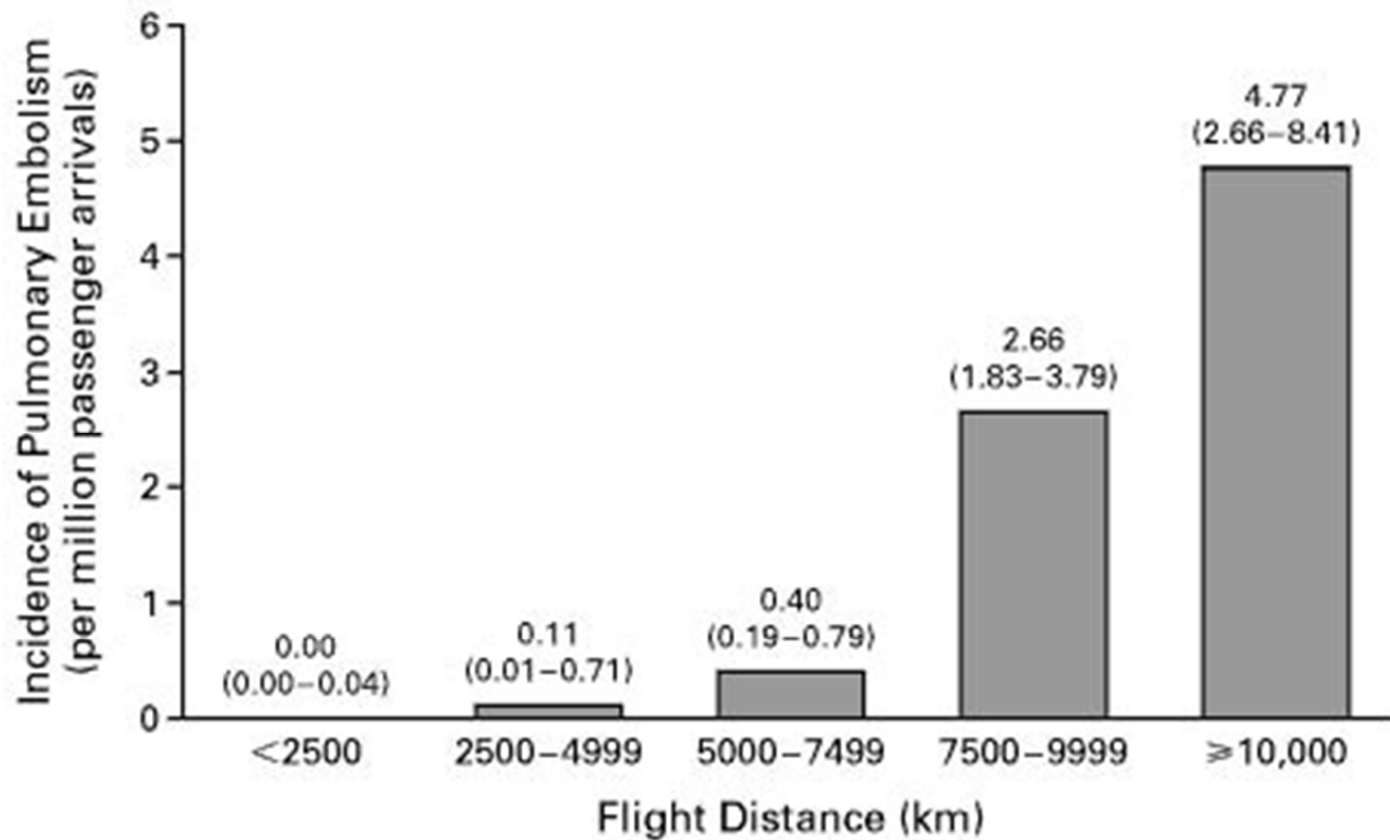
# DVT

- Link between air travel and VTE first suggested in 1954 by report describing new DVT in a 54-year old doctor after 14-hour flight
- Even though infrequent, sheer volume of commercial air passengers cause high prevalence
- Background incidence of symptomatic DVT in general population varies between 1:3000 (<40 y/o) and 1:500 (>80 y/o)
- “Economy class syndrome” – combination of immobility, hemoconcentration and possible coagulation activation by hypobaric hypoxic cabin environment

# VTE Incidence

- Estimated 2 – 4 fold increase in risk for VTE by air travel alone
- DVT: 10% of passengers on >8 hr flights developed symptomless calf DVT
- PE: 0.4 cases per 1 million passenger arrivals
  - NEJM: 135 million passenger arrivals at CDG 1993-2000
    - 170 total pt's transported to local hospitals
    - 56 with confirmed PE
    - 75% women, 75% “completely immobile” during flight
    - >50% of first symptoms reported on jet way after deplaning

# Pulmonary Embolism



# Pulmonary Embolism

- Higher incidence in flights longer than 6 hours
- Incidence likely underestimated
  - Only severe cases identified, patients only observed for 1 hour after arrival, and in-flight deaths excluded
- 56% of patients had either moderate or high VTE risk
- 96% described malaise as first symptom; 50% suffered syncope
- All patients had at least 1 criteria of severe PE
- 1 death – complicated by ischemic cerebral CVA d/t paradoxical embolism

# DVT Risk

- WRIGHT project – 1/6000 for healthy travellers in flights > 4 hours
- Increases by 26% for every 2 additional air travel hours
- Absolute risk of 1<sup>st</sup> episode 1/4600 flights
- Incidence likely higher than reported in literature because of high rate (up to 10%) asymptomatic DVT in this patient population

# Symptomless DVT

- Up to 23% of postop neurosurgical patients
  - 13% of these had proximal DVT progression
- 20% of affected limbs can develop post-thrombotic syndrome
  - Post-thrombotic changes in 54% of affected limbs by U/S
  - Proximal progression in 75% of limbs not anticoagulated
- Asymptomatic PE in 1/3 of distal DVT, 50% of femoral DVT's

# DVT Risk Status

<b>Risk status</b>	<b>Risk factors</b>
Slightly increased	Age >40 Extensive varicose veins Polycythemia Within 72 hours minor surgery
Moderately increased	Family hx VTE Recent MI Pregnancy or early post-natal Estrogen therapy Limb trauma or paralysis
High risk	Thrombophilia Within 6 weeks major surgery Previous CVA Current malignancy

# DVT Risk

- Multivariate analysis by reviewing 24 prior studies with 126 VTE patients
  - >40 y/o – 45%
  - Estrogen use – 31%
  - Varicose veins – 19%
  - Obesity – 17%
  - Inherited thrombophilia – 6%
  - “Other factors” – 7%
- No studies compared seating class of VTE patients with non-VTE patients

## DVT Risk

- Cumulative odds ratio of 2.3 (95 % CI 1.4 – 3.6) for flights >8 hours
- Odds of VTE after >8 hour flights and for highest-risk passengers similar to those of “moderate” DVT risk factors in community
  - Low risk: Bed rest >3 days, >40 y/o, laparoscopic surgery, obesity, antepartum status, varicose veins
  - **Moderate risk: Arthroscopic knee surgery, CHF, HRT, CVA, postpartum, previous VTE, ATIII deficiency, protein C/S deficiency, PT G20210A, heterozygote FV Leiden**
  - High risk: Hip fracture, joint replacement, major trauma, SCI, OCP + FV Leiden, homozygous FV Leiden

## DVT Prevention

- LONFLIT studies: International investigators researching incidence and prevention of DVT in air travel
  - Primary outcomes: DVT diagnosis
  - Secondary outcomes: PE, Death, Superficial thrombosis, Edema
- 2637 patients followed – 1548 low/medium DVT risk, 1273 high risk
  - All flights > 7 hours
  - Patients randomized to below-knee compression stockings vs no stockings

# DVT Prevention

- 50/2637 (1.9%) patients developed symptomless DVT
- 3 in stocking group; remaining 47 in those w/o stockings
- No deaths or PE in any participants
- Approximate 90% reduction in odds of symptomless DVT by wearing below-knee compression stockings
- Odds ratio of 0.1 for asymptomatic DVT by systematic review of 10 trials involving compression stockings with flight duration at least 4 hours

## DVT Prevention - LMWH

- 249 patients high-risk for DVT randomized to placebo, ASA (400 mg daily starting 12 hrs prior to flight x 3 days), and LMWH (enoxaparin) injected 2-4 hrs prior to flight
- Mean age 47 y/o; 65% males
- 4.8% DVT in control group
- 3.6% DVT in ASA group
- No DVT's in LMWH group
- No studies comparing against compression stockings

## DVT Prevention - Recommendations

- Move about cabin every 2 hours at a minimum
- Bulkhead seating if possible
- Avoid prolonged leg crossing; flex/extend ankles periodically throughout flight
- Avoid dehydration by both consumption of clear liquids as well as avoidance of EtOH
- Avoid sedatives (including EtOH)

## DVT Prevention - Recommendations

<b>Risk Category</b>	<b>Prophylaxis</b>
Low	Mobilization and hydration throughout flight
Moderate	Above + Compression stockings
High	Above + Compression stockings ± LMWH

# Case

- 69 y/o woman plans flight from Denver to Frankfurt to visit family
- PMHx: mod – severe COPD (FEV<sub>1</sub> 1.12 – 47% pred) with 2-3 flares/year, tobacco use, HTN
- Uses nocturnal O<sub>2</sub> (2L/min) and occasionally daytime during flares
- Most recent exam: 92% O<sub>2</sub> sat at rest, 90% with moderate exercise
- What advice should she receive to minimize peri-flight health consequences?

## Case - Recommendations

- Patient advised to bring all HFA's and course of prednisone on board aircraft with her
- 6-minute walk recommended to evaluate risk of in-flight hypoxemia (results pending)
- Below-knee compression stockings recommended for DVT prophylaxis
- Advised on maintaining hydration and activity throughout flight
- Pt satisfied – but says “I’m always a zombie for 3 days when I get to Germany” and inquires about strategies to prevent

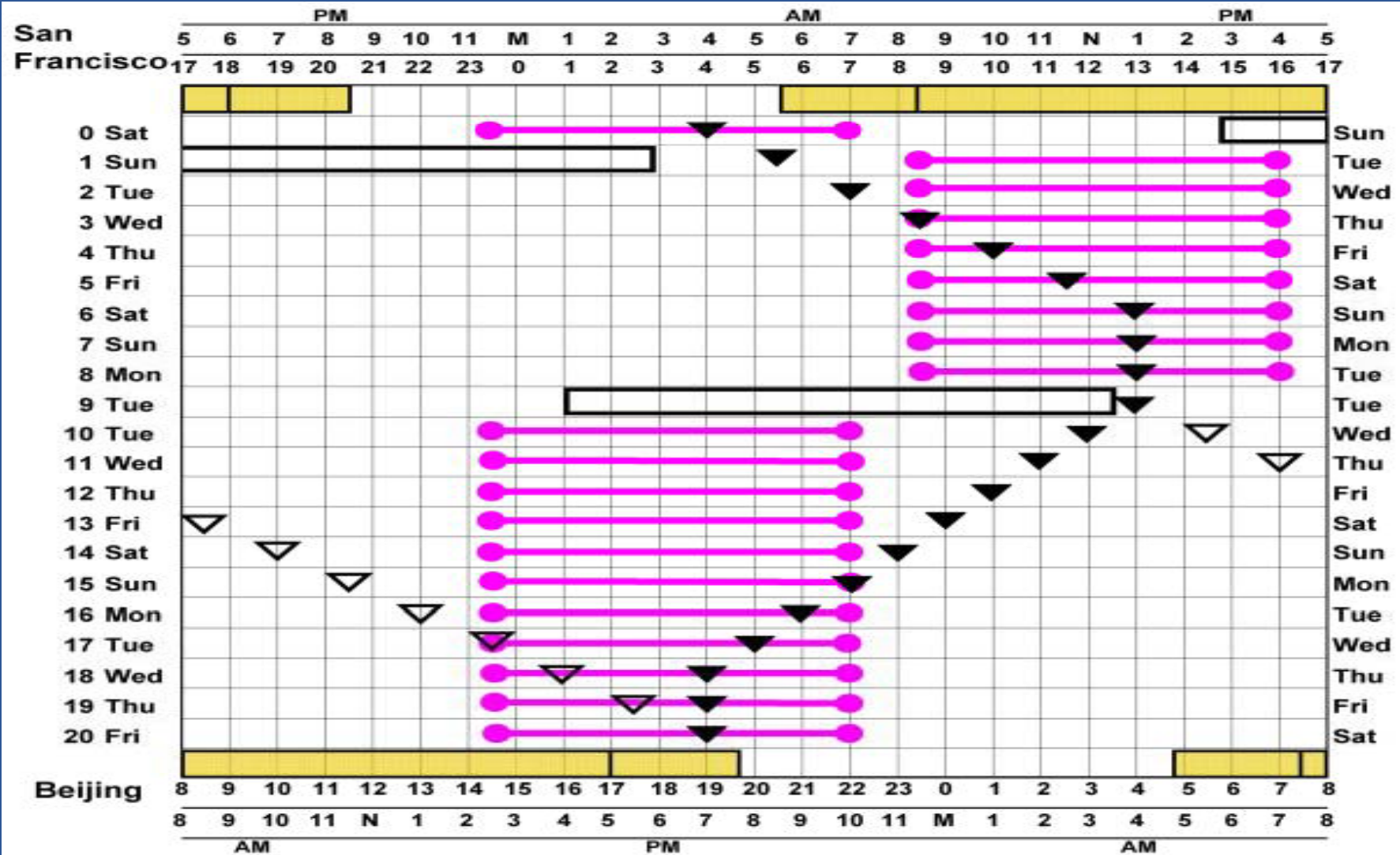
# Jet Lag

- Crossing time zones too rapidly for circadian clock to keep pace
- Insomnia, daytime sleepiness, dysphoric mood, cognitive impairment, and GI symptoms
  - Travel fatigue: weariness, headache
    - Can be reversed with 1-2 good nights of sleep
  - Jet lag persists until circadian clock is realigned
- Circadian clock in SCN of hypothalamus, synchronized to solar light/dark cycle; period slightly longer than 24 hours
  - Resets approx 90 minutes/day when travelling west, and 60 minutes/day when travelling east

# Jet Lag

- Light exposure most important time cue to synch circadian clock
  - Evening exposure – shift to later time (“phase delay”)
  - Morning exposure – shift to earlier time (“phase advance”)
- Seek out light in morning after eastbound travel, and in evening after western travel
- Avoid light just after daylight for eastbound travel, and for first few hours before dusk for westbound travel

# Jet Lag



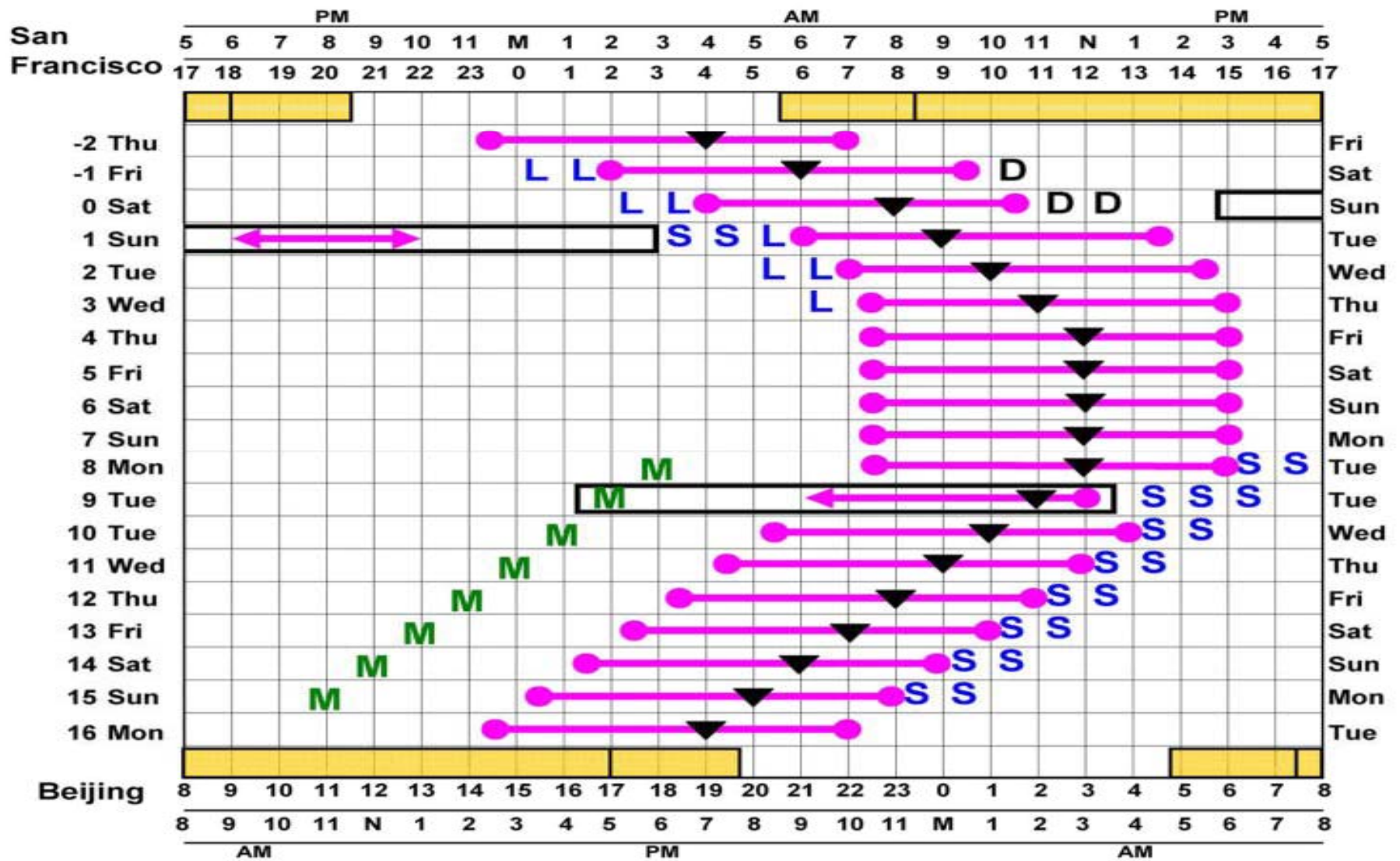
# Melatonin

- Secreted 10 – 12 hours at night, synchronized to light-dark cycle by circadian clock; a “darkness signal”
- Most benefit related to clock-resetting, but at supra-physiologic doses (>1 mg) has hypnotic effects
- Most extensively studied treatment – 8/11 DBPCT’s showed benefit in reported symptoms of jet lag
- Taken few days prior to departure at time to coincide with bedtime at destination (most commonly used for eastbound travel)
- Most common dose in studies = 5 mg
- Marketed in US as 3 mg dose; not approved by FDA for any indication

# Jet Lag

- Sedatives – reduce insomnia, but have no effect on resetting circadian clock
  - Shorter acting agents (Zaleplon > Zolpidem) preferred for in-flight use
  - In-flight immobility may increase DVT risk
- Alertness promoting agents (Armodafanil – Nuvigil)
  - FDA approved for narcolepsy treatment
  - 427 patients flying from US East Coast -> France, monitored x 3 days after arrival, flew back to US on day #4
  - Placebo, 50 mg, or 150 mg armodafanil at 7 am after arrival x 3 days
    - Both armodafanil doses had reduction in daytime sleepiness and increased self-reported alertness on first 2 days
    - High frequency of SE's – HA, nausea, vomiting

# Non-prescriptive Jet Lag Treatment



# Case

- While on a flight from Miami to Denver, you are alerted by overhead page asking any passengers with medical expertise to identify themselves to flight staff
- 38 y/o woman at back of aircraft – syncopal episode when got up to use commode
- EMT, Nurse, and Psychiatrist already attending to pt – care “signed over” to you when arrive
- Patient conscious and conversant, exam unrevealing except for BP 92/60
- How would you proceed?

# In-flight Medical Emergencies

- 2000 FAA study – 13 events per day on US Domestic Flights
  - Likely underestimates since included only events serious enough to involve ground-based medical services
- International events estimated at 1/14,000 passengers
- Aviation Medical Assistance Act (1998): Limited “good Samaritan” protection
  - “A person who renders emergency medical services or aid to an ill, injured or unconscious person, at the immediate scene of an accident or emergency that has caused the illness, injury or unconsciousness, is not liable for damages for injury to or death of that person caused by the person's act or omission in rendering the medical services or aid unless that person is grossly negligent.”

# In-flight Medical Emergencies

- No US litigation yet against responding physicians
- US, Canada, UK – no legal duty to respond unless pre-existing physician-patient relationship
- Many other European countries and Australia impose a legal obligation to respond
- Responding passenger must be:
  - Medically qualified
  - Volunteer
  - Render care in good faith
  - Receive no monetary compensation
  - Provide medical care similar to care others with similar training would provide under same circumstances

# Medical Resources Aboard Aircraft

- 2004 – FAA mandates all commercial aircraft with at least one flight attendant to carry AED
- Most airlines train flight attendants in AED use, and some only allow trained staff to attach and operate
- 1986 – all commercial aircraft with >30 passenger seats carry emergency medical kit
  - “Expanded” kit required in 2004
- Ground-based assistance: 24-hour ground-to-air consultation staffed by physicians board-certified in EM and with training in aviation medicine
- “Potential pharmacy”

# Enhanced On-Board Emergency Kit

- Medications

- 325 mg APAP
- 25 mg po Benadryl
- 50 mg injectable Benadryl
- 325 mg ASA
- 1 Bronchodilator HFA
- 1 ampule D50
- Epinephrine 1:1000
- Epinephrine 1:10,000
- Lidocaine 5 cc, 20 mg/ml
- SL NTG 0.4 mg
- Injectable sedative anticonvulsant
- Injectable diuretic
- Injectable antiemetic
- Injectable corticosteroid
- Medication for postpartum bleeding
- Injectable atropine
- 500 ml 0.9 NS

- Equipment

- Stethoscope
- BP cuff
- Oropharyngeal airways – all sizes
- Syringes
- Needles
- IV catheters
- Antiseptic wipes
- Disposable gloves
- Urinary catheter
- IV start kit
- Venous tourniquet
- Sponge gauze
- Tape adhesive
- Surgical mask
- Non-mercury thermometer
- CPR mask – all sizes
- AMBU bags with masks

# In-flight Emergencies

- Cardiac: 20 – 30%
  - Chest pain and angina
- Neurologic: 15 – 30%
  - Syncope, seizures, and dizziness
- Pulmonary: 5 – 10 %
  - RAD and COPD exacerbations
- Nausea, vomiting, abdominal pain – rarely emergencies
- Allergic reactions, including anaphylaxis
- Hypoglycemia
- Violent behavior
- Trauma, especially head injury

# Approach to Selected Emergencies

- Chest pain – most common cause of death & diversion
  - O<sub>2</sub>, ASA, Nitrate, IV access (if needed)
  - AED for rhythm analysis
  - Lower aircraft altitude
  - Consult with ground based MD support & divert if necessary
- Syncope – 2<sup>nd</sup> most common cause of diversion
  - AED to assess rhythm
  - Vasovagal overwhelmingly most common cause – supportive tx
- Unresponsiveness
  - AED with shock if needed
  - IV access with empiric D50
  - O<sub>2</sub>
  - Diversion

# Flight Diversion

- Persistent unresponsiveness, chest pain, shortness of breath, abdominal pain not responding to initial interventions
- Severe agitation
- Refractory seizures
- 2000: 13% of all in-flight medical incidents aboard domestic aircraft resulted in diversion
- Significant cost to airline industry – up to \$100,000
- Ultimately flight captain's decision, and role of physician is as a consultant

# The Process

- “Is there a doctor on board the aircraft?”
- Verify license and medical qualifications
- Complete yet focused hx & exam, informing patient/family & then flight crew of impression
- Request diversion if condition serious
- Discuss with ground-based medical staff if requested
- Document!
- Provide no treatment you do not feel comfortable administering

## AED Use



- Left pad on right upper chest and right pad on left lateral chest
- Do not place over patches or pacemakers
- Press “analyze” & stay clear
- AED will advise if shock needed
- Clear before shock!

# Conclusions

- Preflight medical assessment important in patients with significant CV, Pulmonary, and CNS disease
- Decompensated CV disease, Pulmonary HTN, and recent surgery or PTCA a contraindication to flight
- Hypoxia screening best done by pulse ox (<95% warrants evaluation) and 6 minute walk, but HAST best studied
- DVT risk increased up to 2x, and associated with flight duration as well as pt's baseline DVT risk factors
- Compression stocking recommended for moderate risk and LMWH an option for highest risk patients

# Conclusions

- Jet lag best treated by appropriately timed light exposure prior to and after arrival, as well as melatonin (>3 mg) prior to desired sleep
- Stimulants limited due to harsh side-effect profile; sedatives not recommended in-flight b/c of increased DVT risk
- Approximately 1/750 flights have medical emergencies
- Syncope most common, followed by GI symptoms
- Limited yet reasonable medical kit at disposal
- Diagnose and stabilize pt, and advise flight staff of further treatments patient may need

# Conclusions

- Ultimate authority regarding diversion of aircraft is flight captain
- MD's recommended to fly with copy of medical license and CPR card
- AED use and basic IV insertion skills recommended, especially for longer duration flights
- Document all treatments provided
- No fear of lawsuit as long as provide treatments within limits of licensure and in line with what peers would have done

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