



**Federal Aviation  
Administration**

# **Aeromedical Safety Considerations for Transportation of Patients by Airline**

**Presented at: Brasilia**

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**Director, Civil Aerospace Medical Institute**

**Date: 2011**



***General Considerations for Patient  
Transport by Airline Aircraft***

# Aviation Stress Factors



## INDIVIDUAL:

Physical Fitness  
Psychological Fitness  
Alcohol Consumption  
Medication Use  
Illicit Drug Use  
Diseases & Illnesses  
Fatigue  
Circadian Rhythms  
Nutrition & Hydration  
Emotional Stress

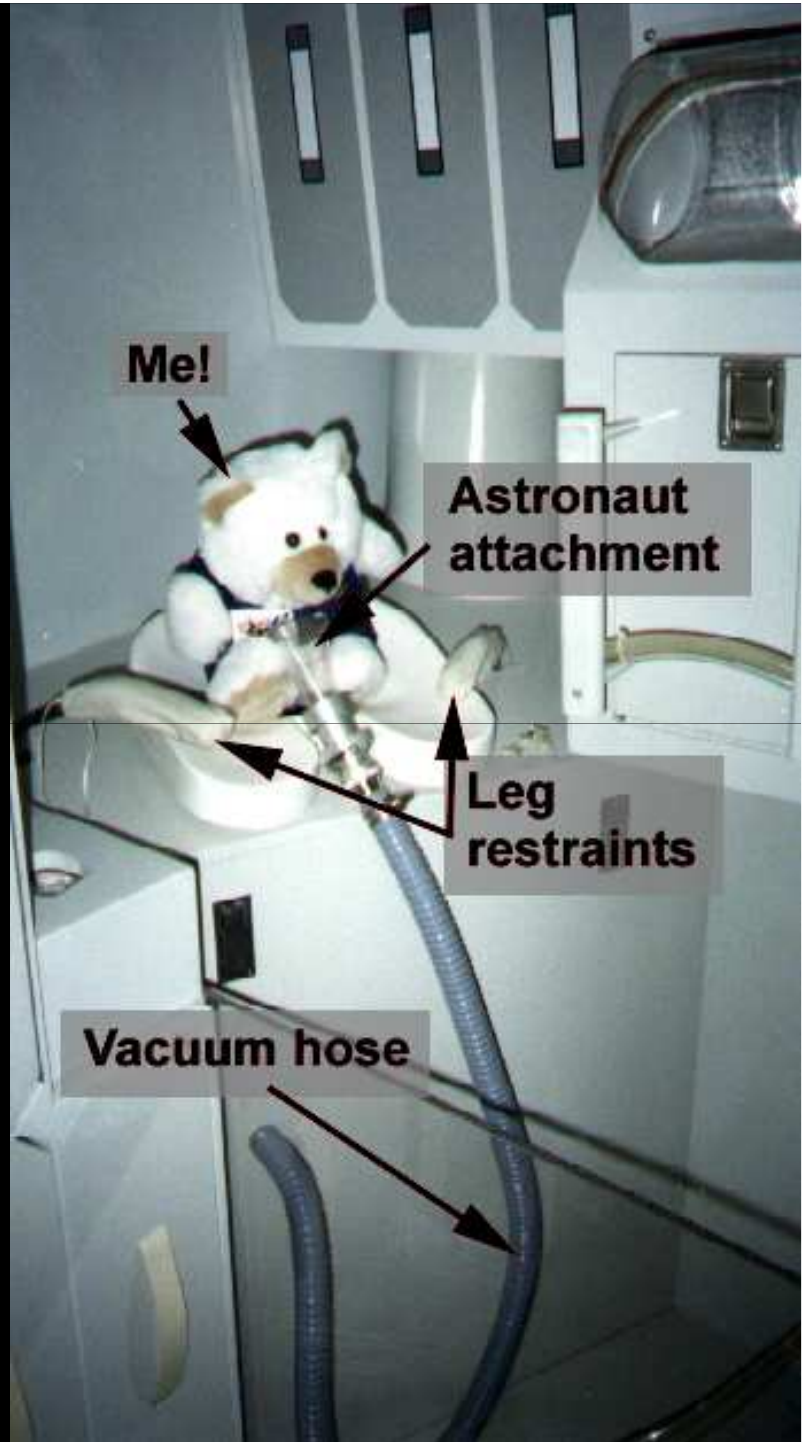
## ENVIRONMENT:

Barometric Pressure  
Solar & Cosmic Radiation  
Temperature and Humidity

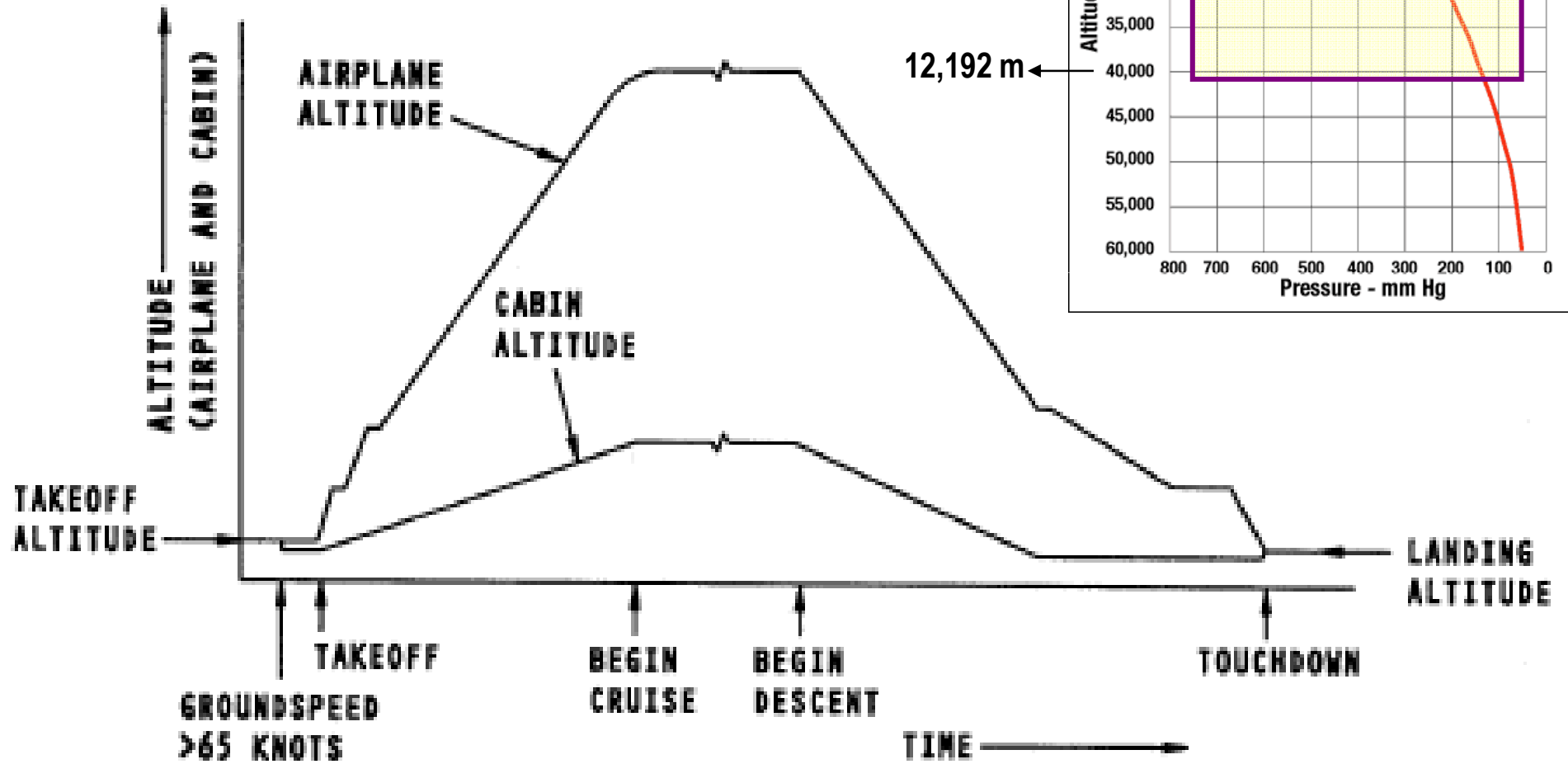
## OPERATIONAL:

Chemical/Biological Hazards  
Automation Issues  
Workload & Performance  
Decision-Making & Judgement  
Crew Resource Management  
Spatial Disorientation  
Life Support Systems  
Personal Protective Equipment  
Acceleration Forces  
Human-Machine Interface  
Human-Human Interface  
Noise & Vibration  
Airsickness  
Transmeridian Flights  
Cabin Air





- Cabin altitude during flight is between 5,000 and 8,000 ft (1,524 m and 2,438 m)
- This results in reduced barometric pressure with a decrease in partial pressure of oxygen ( $PO_2$ )
- Barometric pressure is 760 mmHg at sea level with a  $PaO_2$  (arterial  $O_2$  pressure) of 98 mmHg
- Barometric pressure at 8000 ft will be 565 mmHg with  $PaO_2$  of about 55 mmHg
- This corresponds to a blood oxygen saturation of 90%



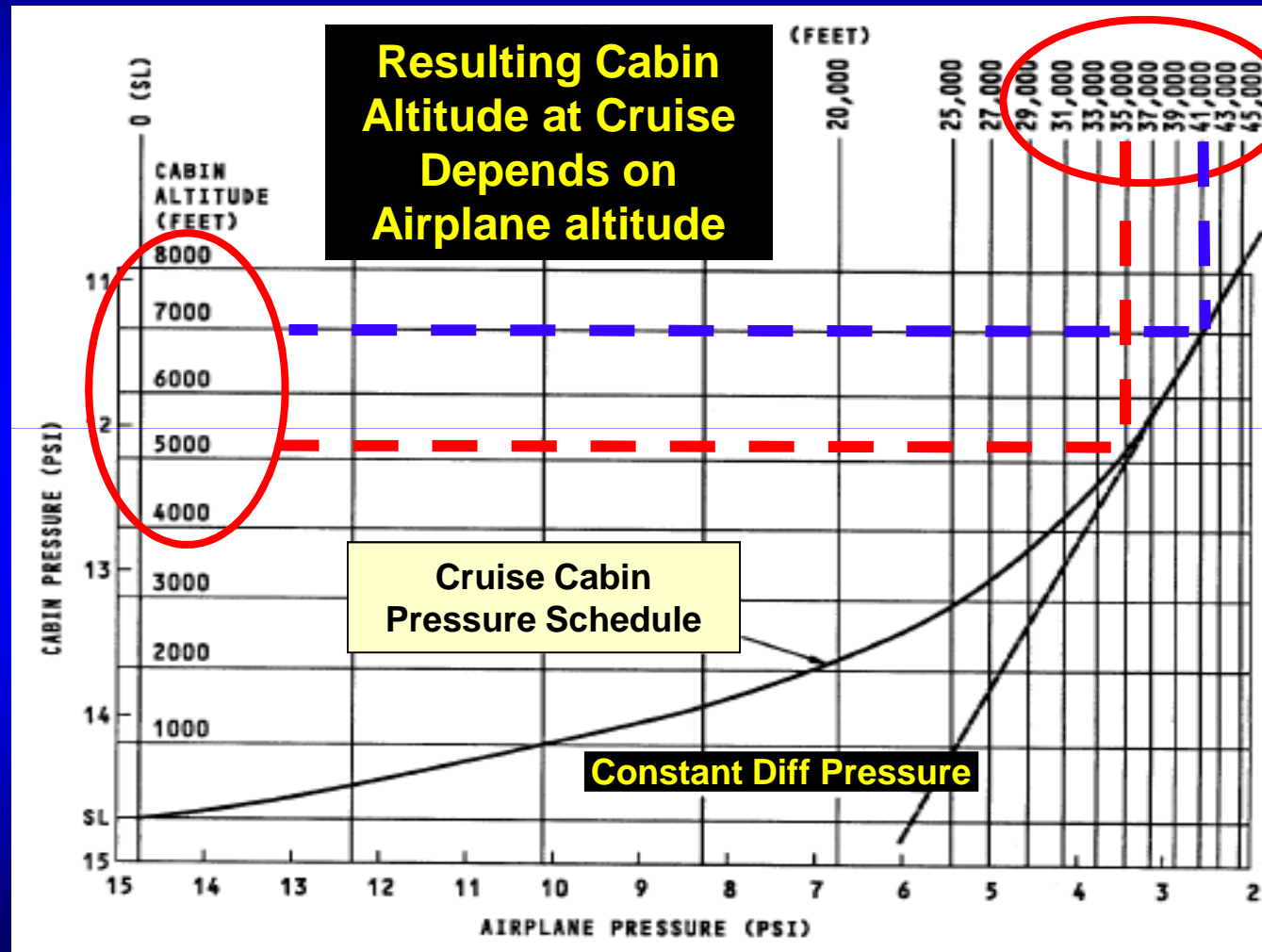




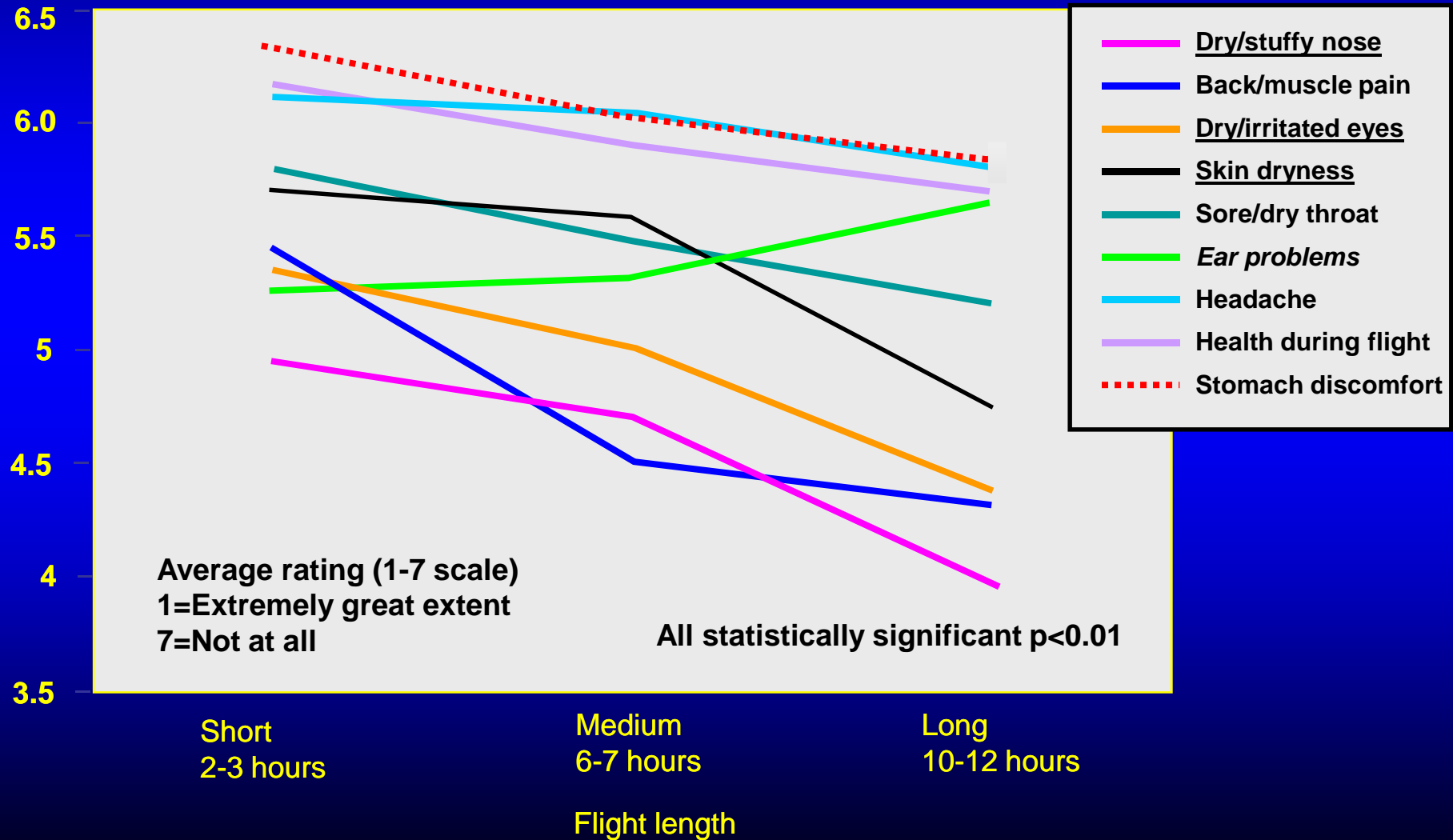




# Typical Cruise Cabin Pressure Schedule



# Health-Related Symptoms as a Function of Flight Length



# Other Stress Factors

- Carrying luggage
- Walking long distances
- Flight delays or cancellations
- Cramped seating
- Reduced mobility



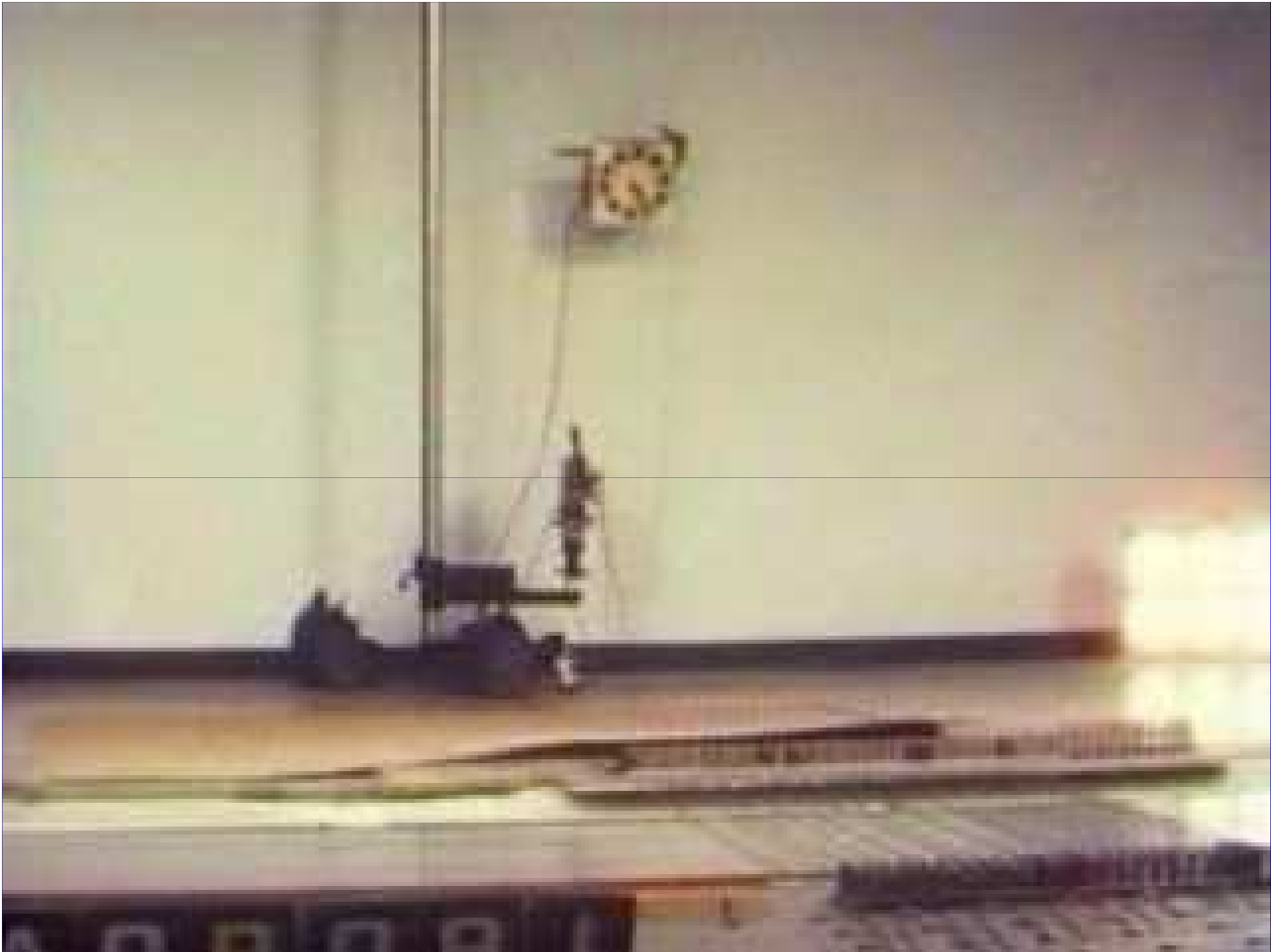
***Emergency Evacuation  
Considerations***

# Impact Survivability









CAMI  
SLED TEST



A 96092

CAMI

**S C I E N C E**



*Push Button  
Buckle*

*Airbag*

*Inertia Reel*

**S A F E T Y**

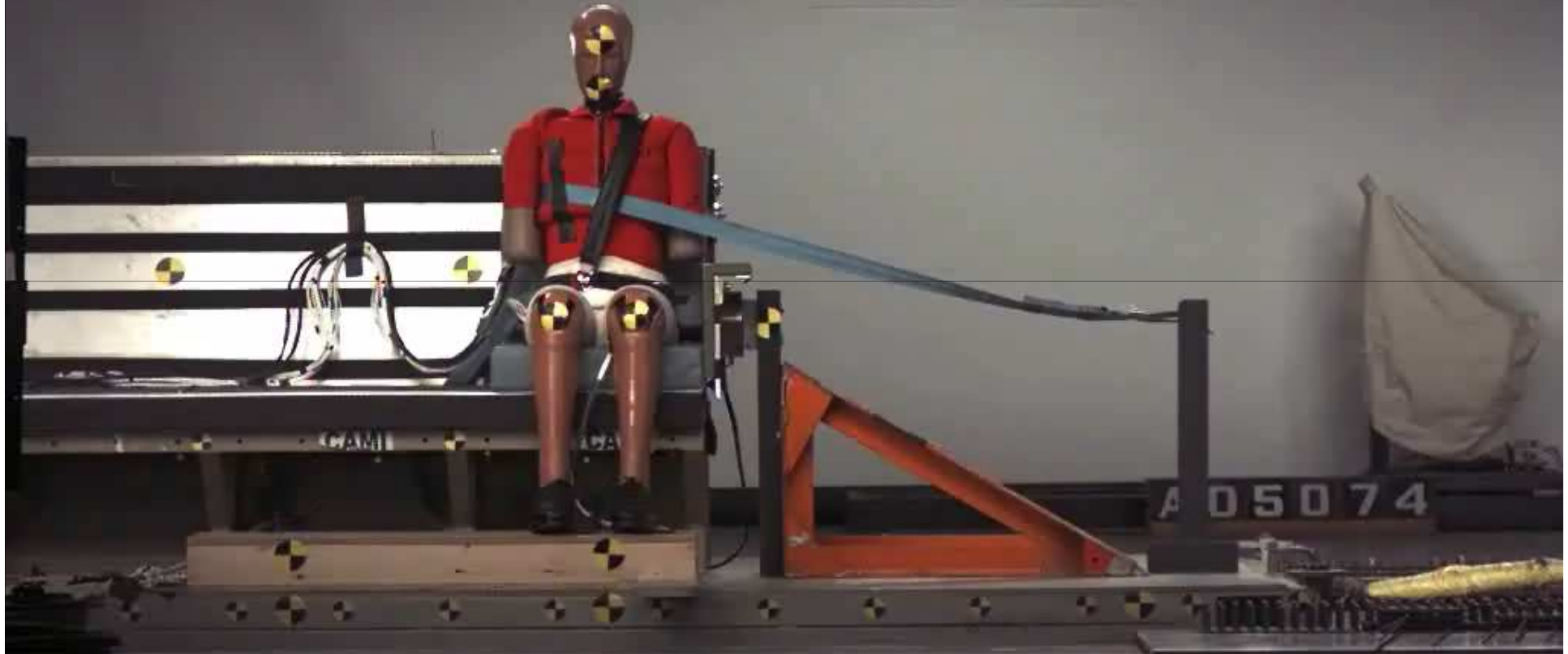
 CAMI   
SLED TEST

A07009





 **CAMI**   
SLED TEST



# Evacuation Procedures



## EVACUATIONS AT U.S. AIRPORTS

September 1997 – June 1999

46 evacuations

2,651 passengers

232 injured (8%)

~ 1 evacuation every 11 days





# Toronto (August 2005)



A-340

Bad weather

Plane ran off the runway





Safety and Survivability Issues in Civil Aviation



Federal Aviation Administration

# SIMULATED EVACUATION

(03/27/2006)

*853 passengers and 20 crew*

*Completed in 80 seconds*

*8 of 16 doors in operation*

*33 injuries (including 1 leg fracture)*



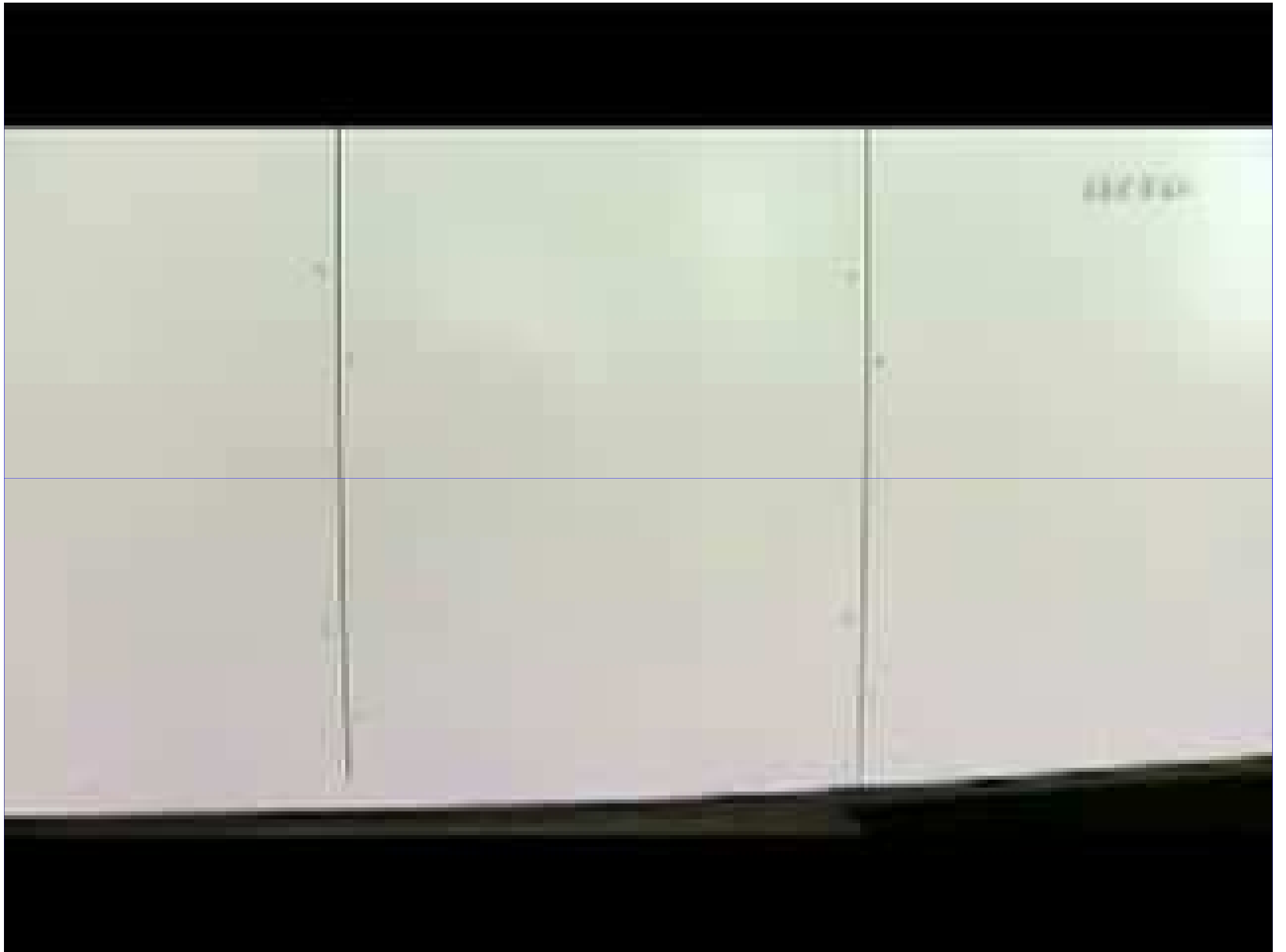
**U.S. General Population**  
*36% Afraid of Heights*  
*18% Afraid of Flying*



**Medical Guidelines for Airline Travel**



**Federal Aviation  
Administration**



All 157 passengers and eight crewmembers safely evacuated the China Airlines Boeing 737-800 that caught fire after landing at Okinawa Naha Airport.



AP/WIDE WORLD











NTSB reported that the current failure rate of slides in the U.S. is about 37%



Do we have Federal regulations  
addressing the emergency evacuation of  
passengers with reduced mobility or  
disabilities?

# Travelling with Service/Assistance Animals









Medical Guidelines for Airline Travel



Federal Aviation  
Administration





Medical Guidelines for Airline Travel



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Administration







*Common Inflight  
Medical Problems*

# Is there a neurologist on this flight?

J.I. Sirven, MD; D.W. Claypool, MD; K.L. Sahs, RN; D.M. Wingerchuk, MD; J.J. Bortz, PhD;  
J. Drazkowski, MD; R. Caselli, MD; and D. Zanick, MD

During a total of 4,003,809 flights (571,972 flights per year) flown by a carrier from 1995 to 2000, there were 2,042 separate in-flight incidents requiring medical consultations.

*Table 1 Mayo In-flight Advisory Report's symptom classification of air-to-ground medical calls for a US airline over a 6-year period*

Category	Total no. symptoms	Incidence (%)	Total no. of diversions	Diversion rate (%)	Likelihood of diversion* (%)
Allergies	71	4	4	1	6
Bleeding	42	2	6	2	14
Cardiovascular	274	13	108	35	39
Deaths	8	0	1	0	13
Diabetes	72	4	6	2	8
Gastrointestinal	201	9	21	7	10
Infection	165	8	1	0	0.1
Neurologic	626	31	107	34	17
Obstetric	46	2	11	4	24
Respiratory	173	9	30	9	17
Psychiatric/intoxication	46	2	2	1	4
Unknown/undefinable	318	16	15	5	5

\* Total no. of diversions by category/total no. of symptoms.

**Table 2** Incidence of neurologic symptoms and diversions over a 6-year period for a US airline

Category	Total no. of symptoms	Incidence of symptom*	Incidence per 10 million passengers per year†	Total no. of diversions	Diversion rate (%)	Likelihood of diversion (%)	Total US cost‡ (\$)
Seizures	131	26,237	4.19	31	29	24	2,583,333
Dizzy/vertigo	354	9,694	11.3	36	34	10	3,000,000
CVA	21	163,420	0.67	5	4	24	416,666
Numbness	6	571,972	0.19	0	0	0	0
Tremor	2	173,324	0.06	0	0	0	0
Headache	37	92,852	1.18	1	1	3	83,333
Pain NOS	25	137,493	0.8	5	6	20	416,666
Trauma	10	344,561	0.32	1	1	10	83,333
Confusion	6	571,972	0.19	4	3	66	333,333
LOC/syncope	34	102,137	1.08	24	22	71	2,000,000
Total cost of diversions for neurologic symptoms							8,916,664

\* Incidence of one symptom every N flights based on 571,972 flights per year.

† Incidence of symptom per 10 million passengers per year based on an average of 52,022,571 passengers per year from 1995 to 2000.

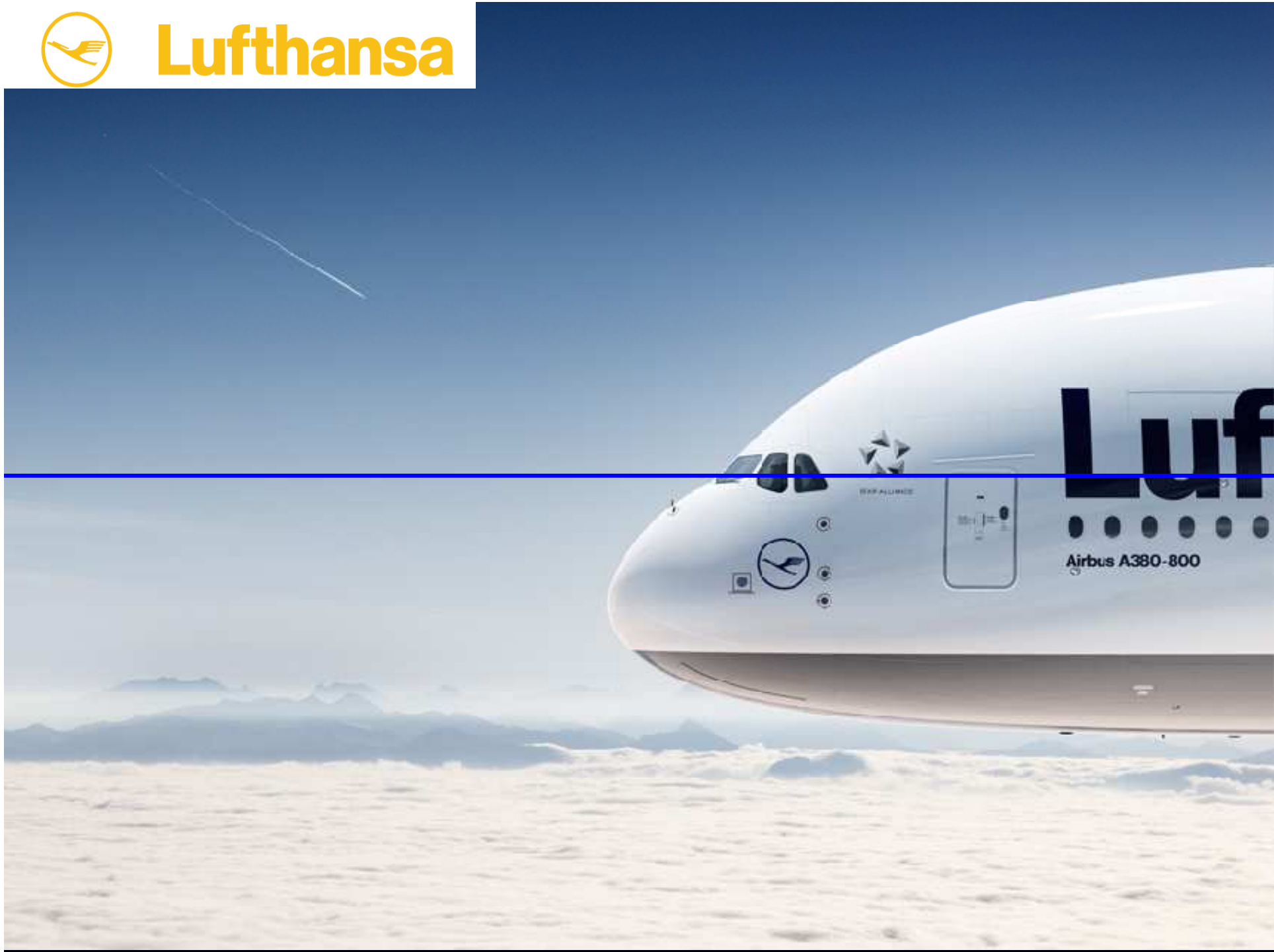
‡ Total US cost at \$50,000 per diversion is an extrapolation of the data, assuming that these data represent 10% of the airlines industry per year.

CVA = cerebrovascular accident; NOS = no organ system; LOC = loss of consciousness.

Although neurologic complaints occurred more often than other medical symptoms, the likelihood of these serious symptoms occurring in-flight is quite low, affecting only 0.01% of all flights.

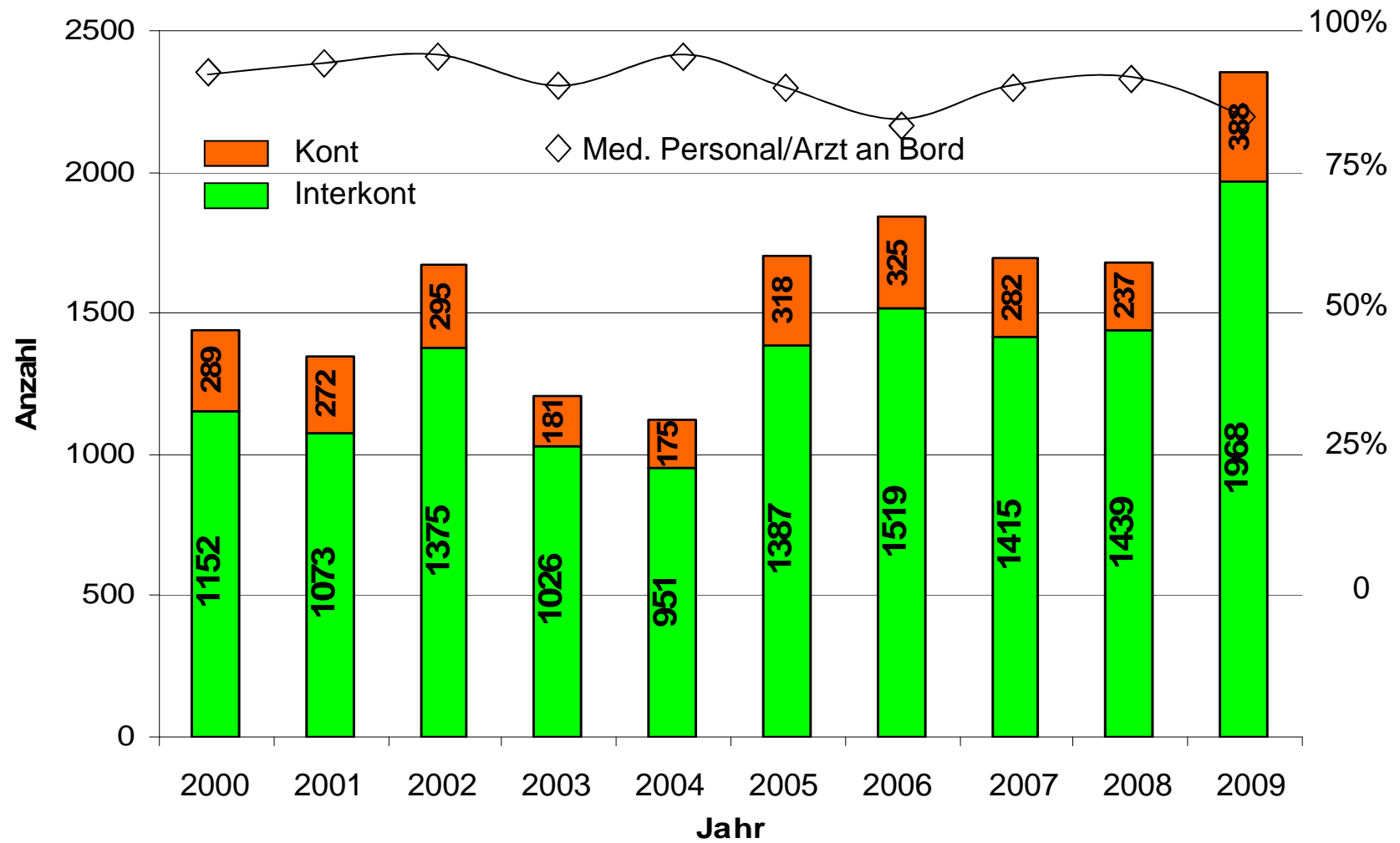


**Lufthansa**

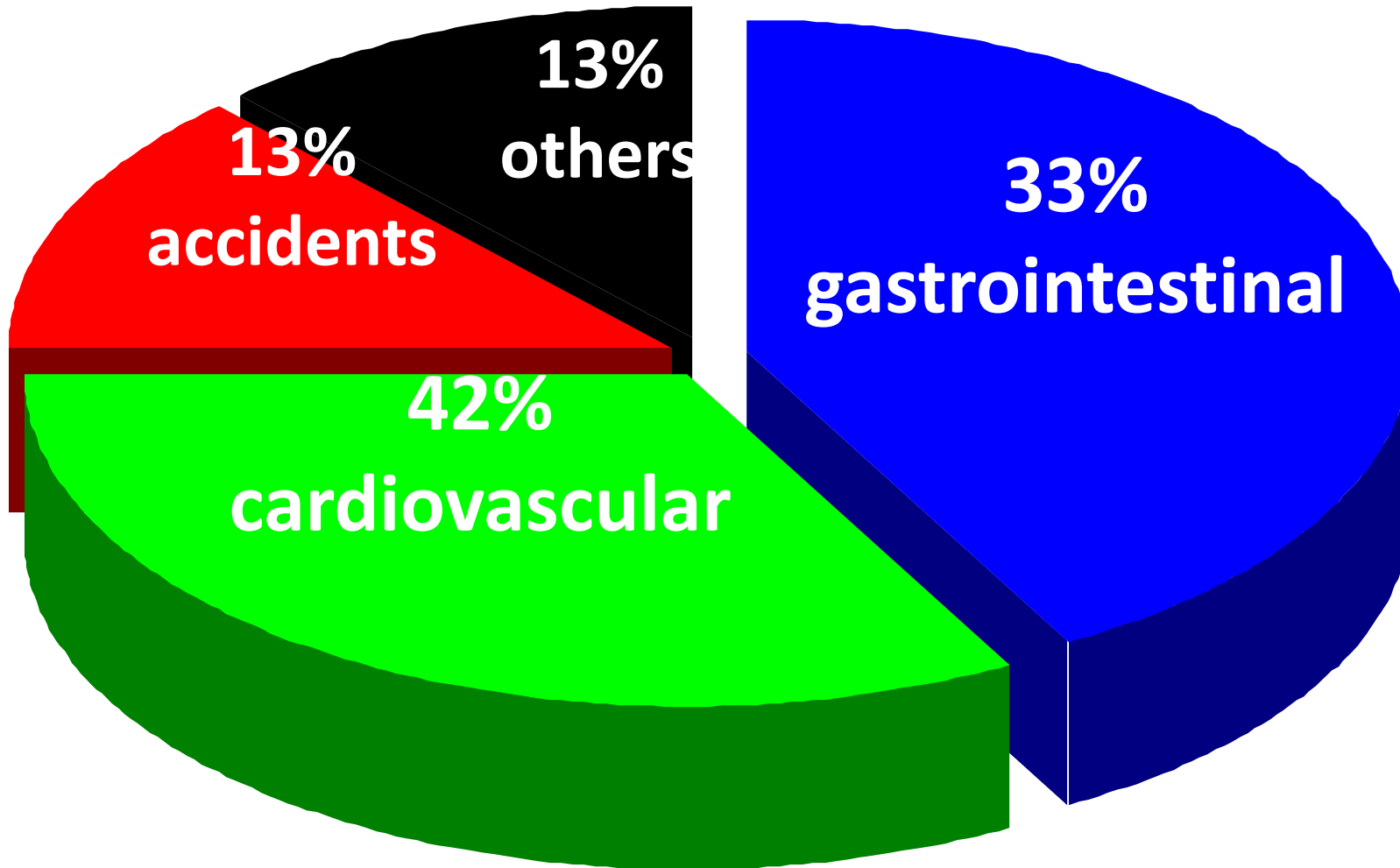




# Analyzed inflight medical emergencies

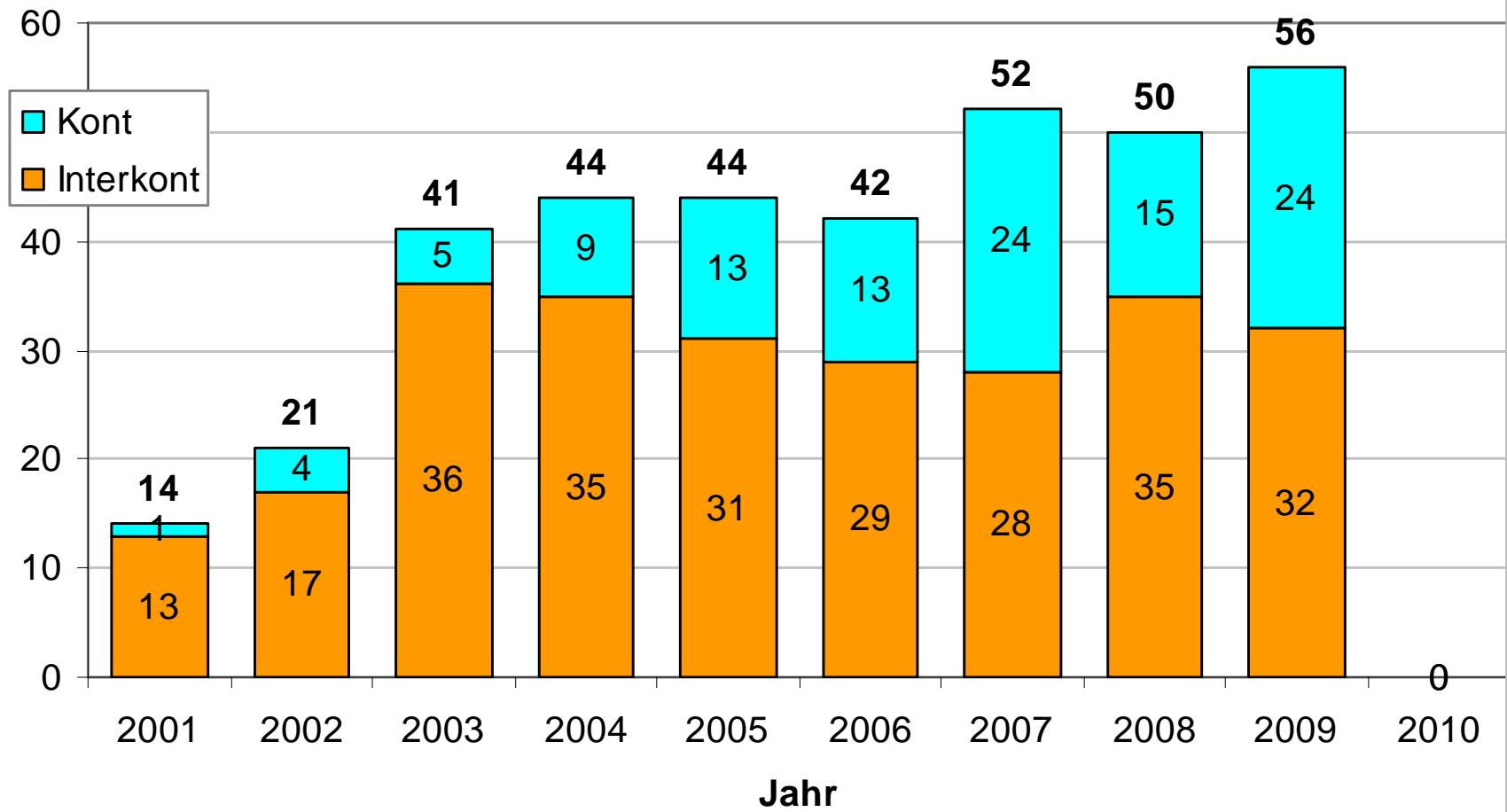


# Distribution of medical emergencies

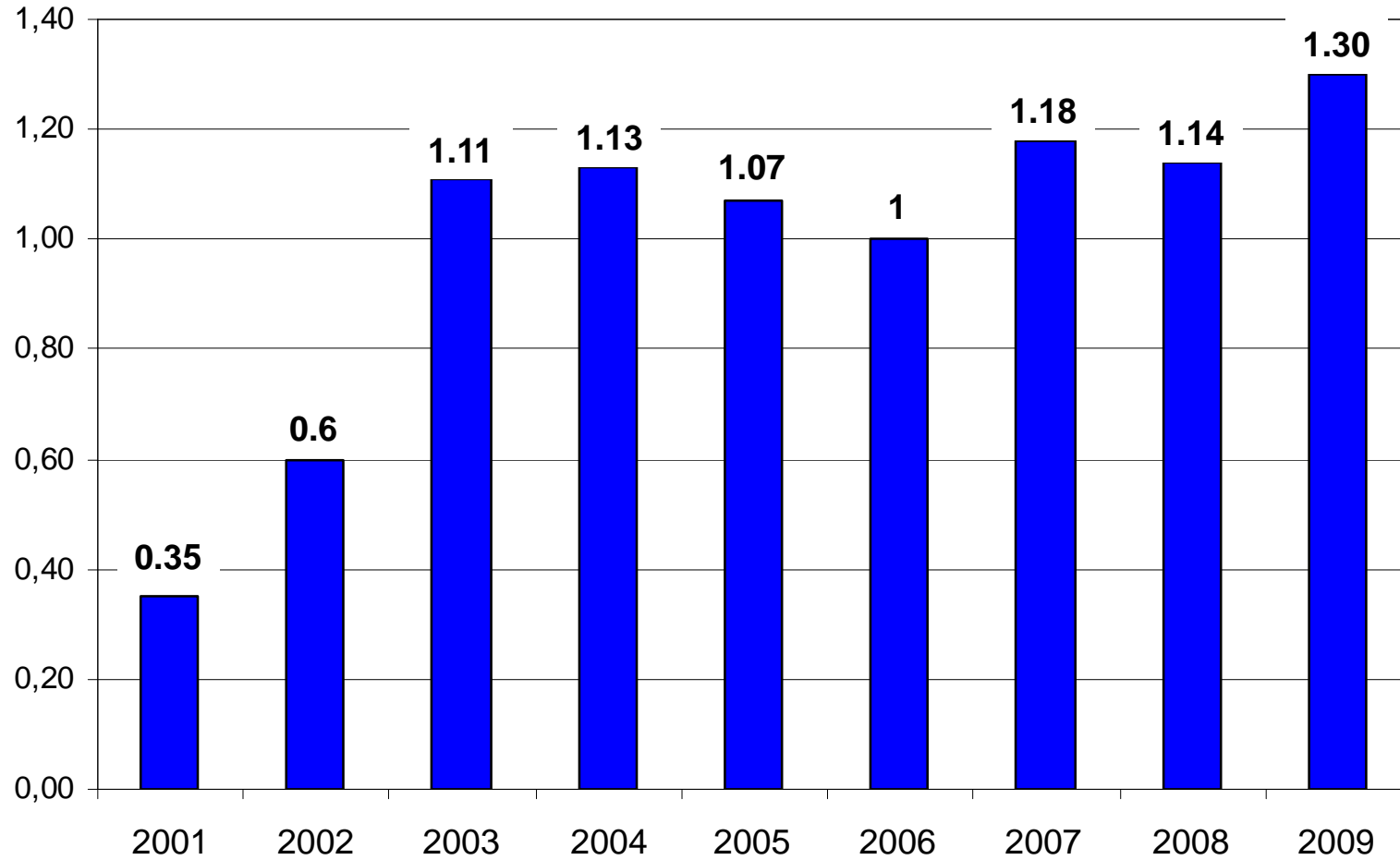


# Medical Diversions

Anzahl



# Diversions per 1 millionen passengers (data: OZ)



**MedAir Inc.**

*Dr. Paulo Alves*

Inflight Deaths and AED Utilization in  
Commercial Airlines: *January 2001  
to December 2008*

1 death per every 7.7 million passengers

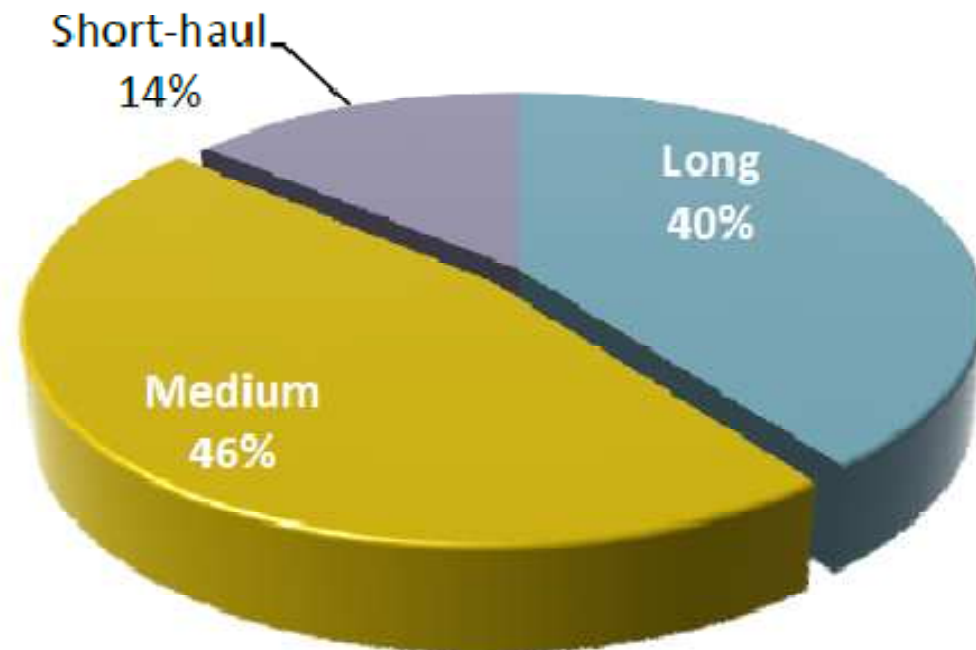
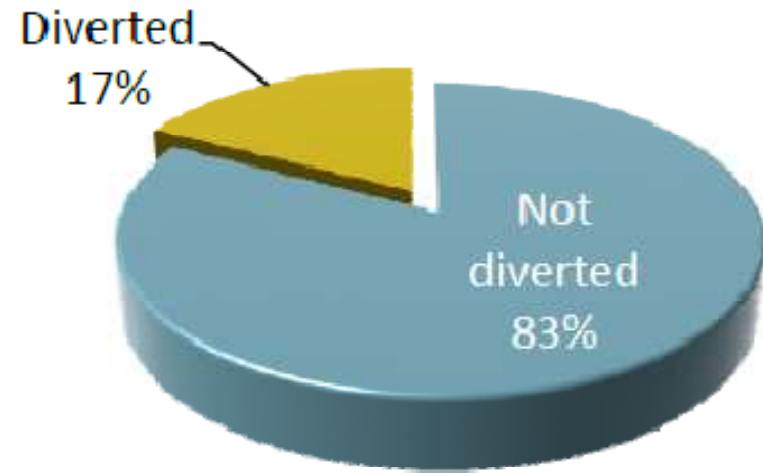
4.8 deaths per month

**MedAir Inc.**

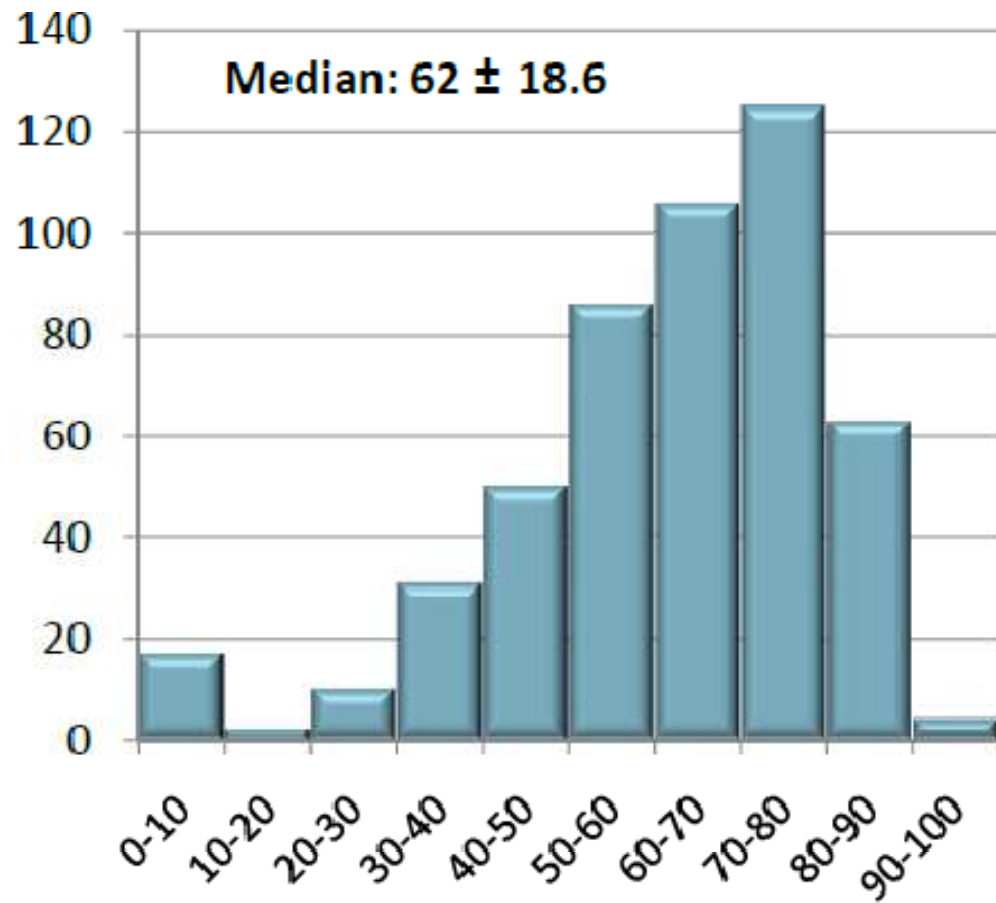
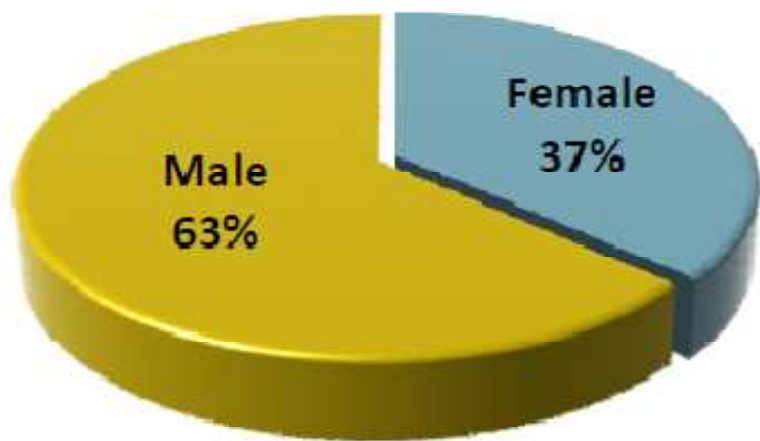
*Dr. Paulo Alves*

# Flights sample

- 48 airlines
  - All continents
- Median original flight duration:  $240 \pm 192$  minutes



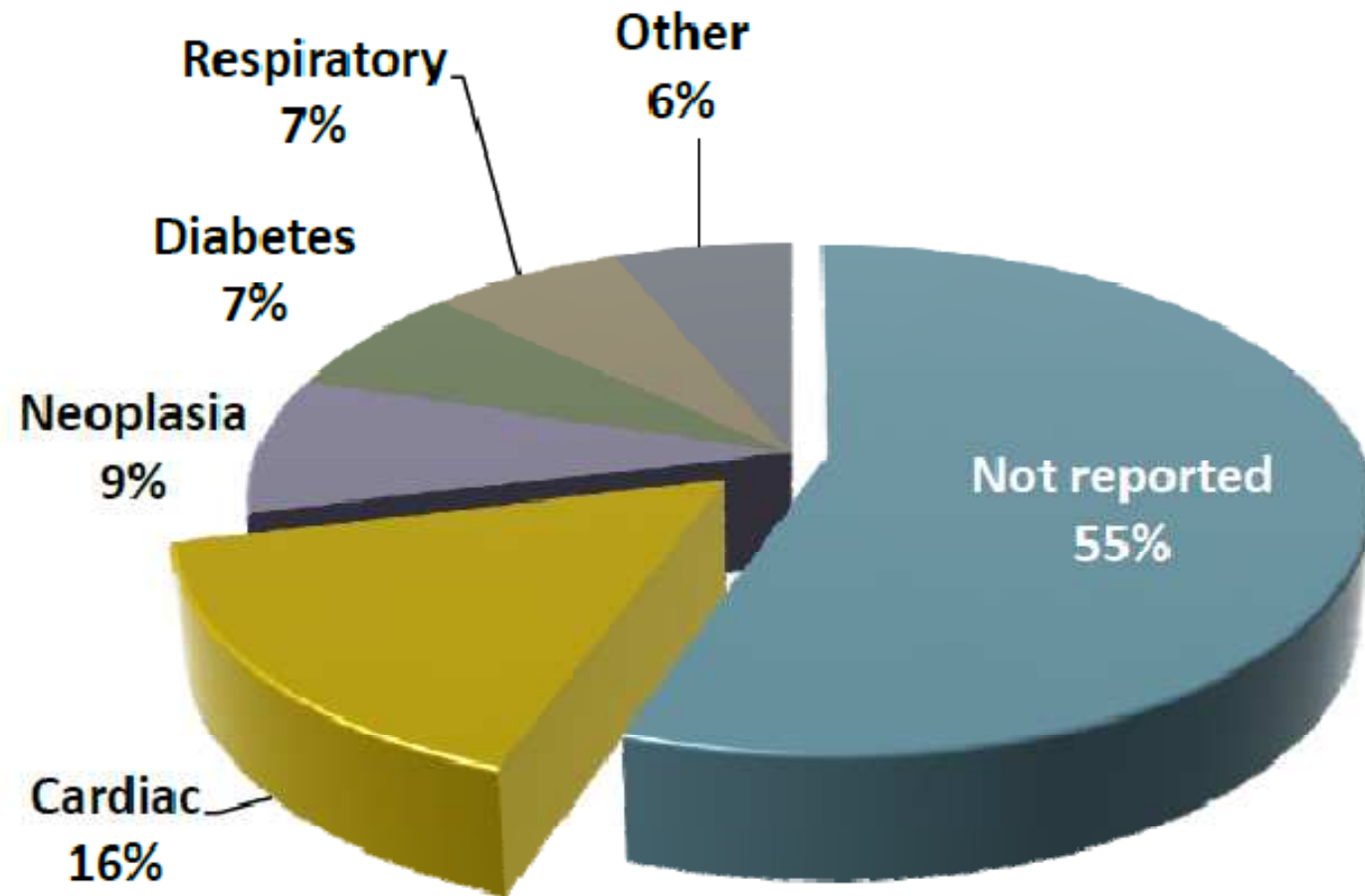
# Gender and Age



**MedAir Inc.**  
*Dr. Paulo Alves*

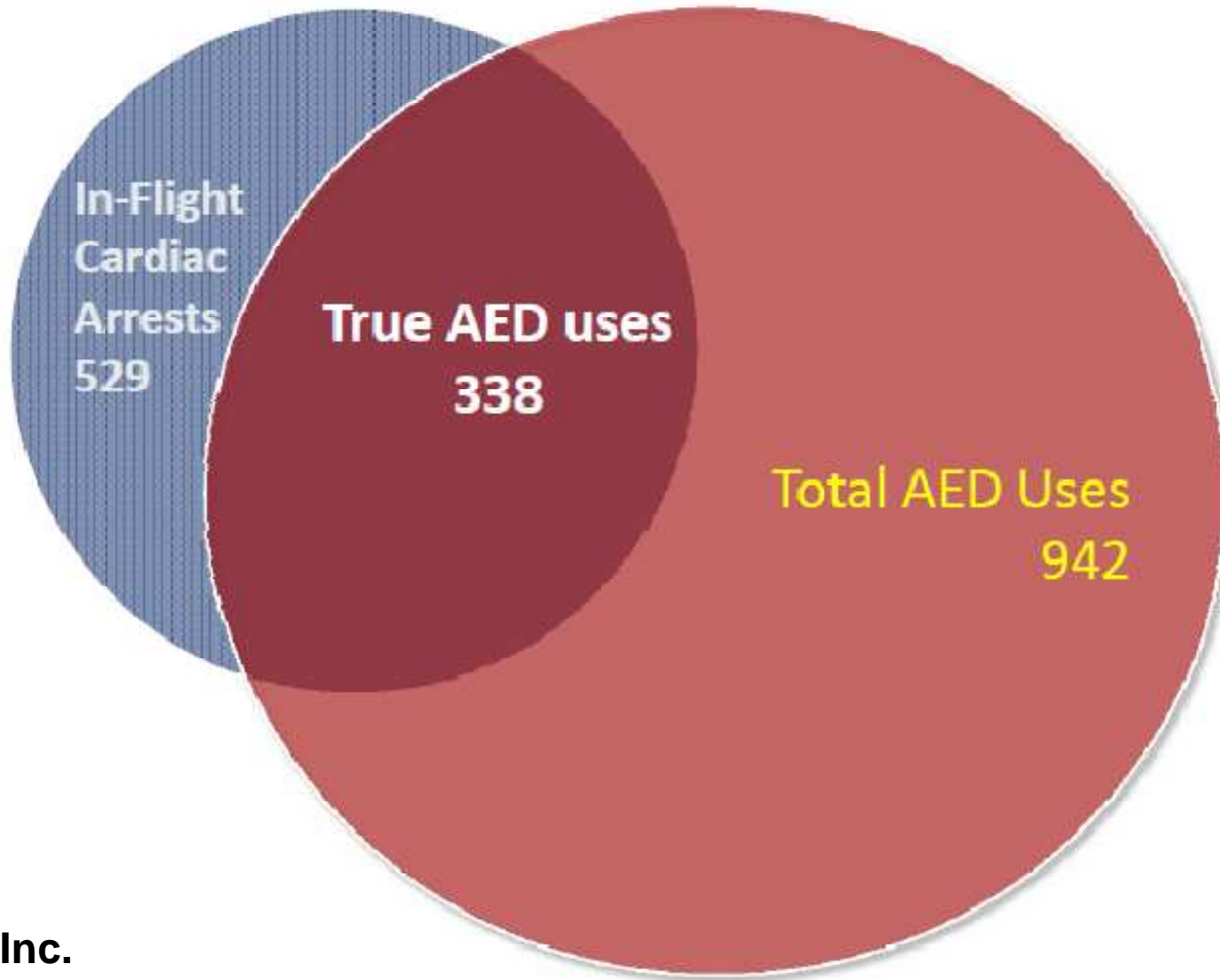


# Pre-existent Conditions



**MedAir Inc.**  
*Dr. Paulo Alves*

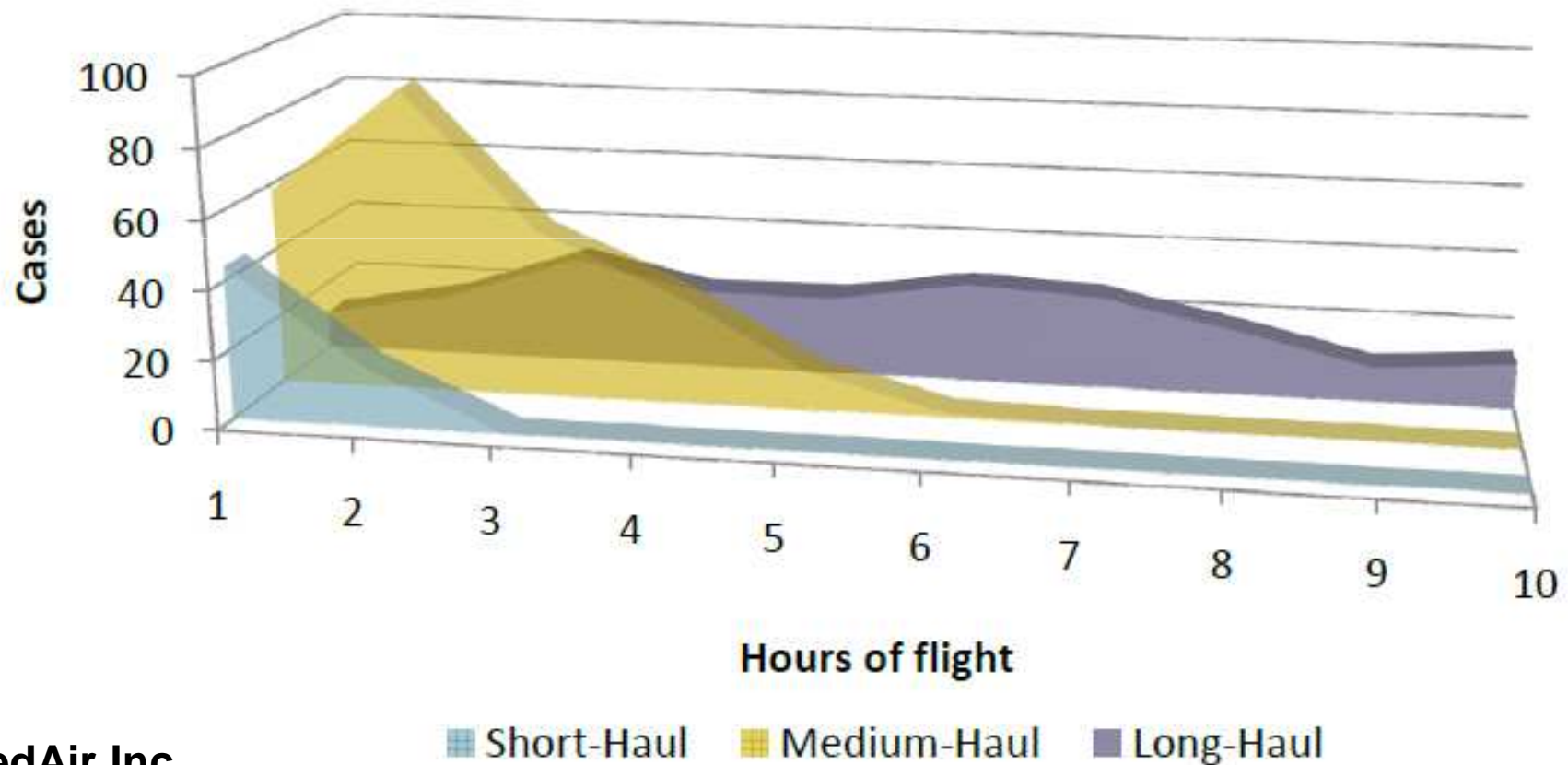
# Results



**MedAir Inc.**  
*Dr. Paulo Alves*

# Time of Event During Flight

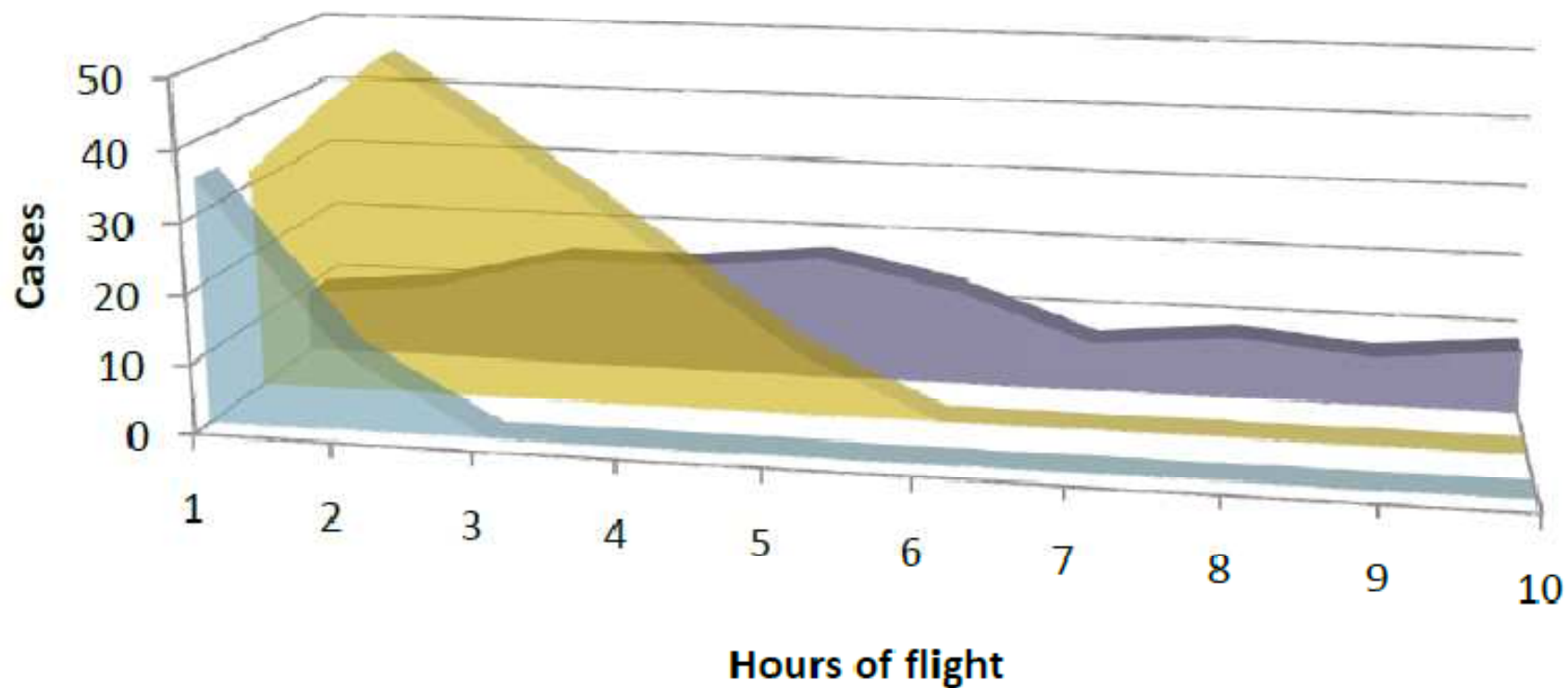
## All Cardiac Arrests



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*Dr. Paulo Alves*

# Time of Event During Flight

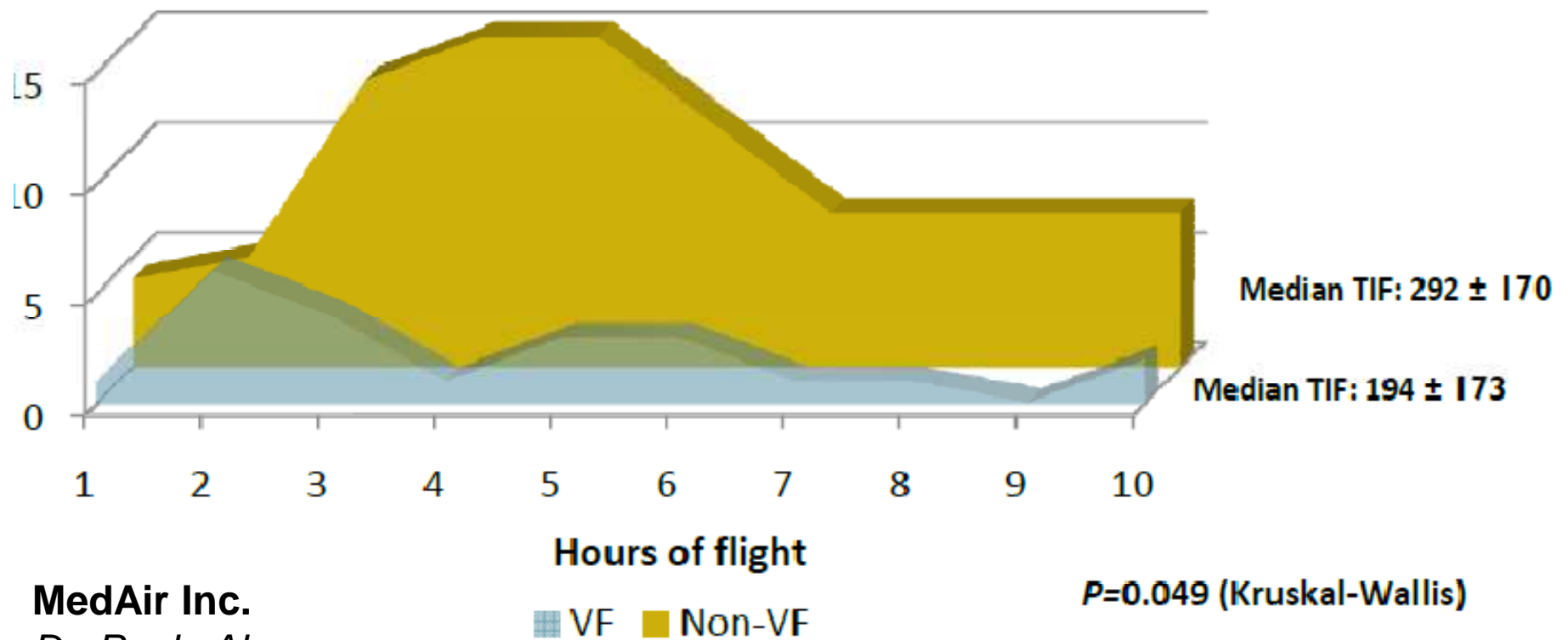
## True AED uses



**MedAir Inc.**  
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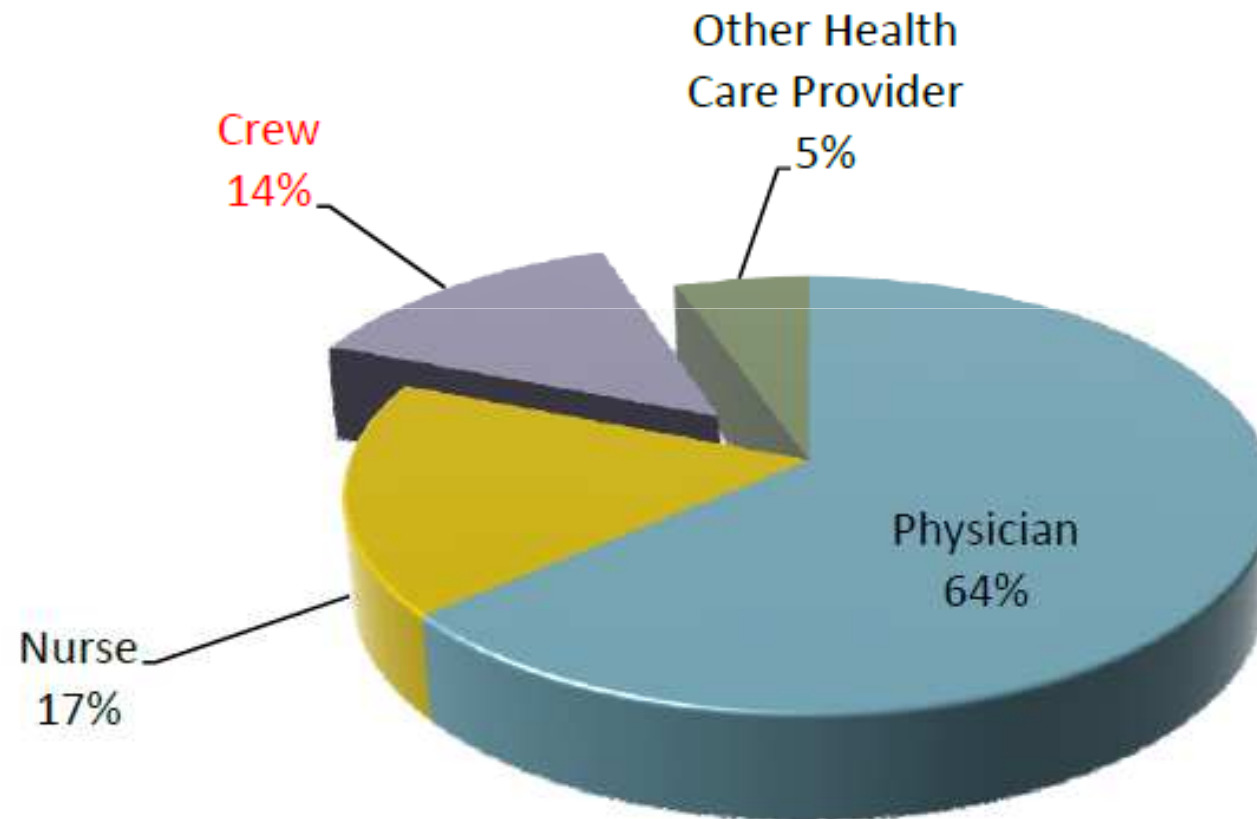
■ Short-haul   ■ Medium-Haul   ■ Long-haul

# VF vs. Non-VF in Long-Haul Distribution Along the Flight



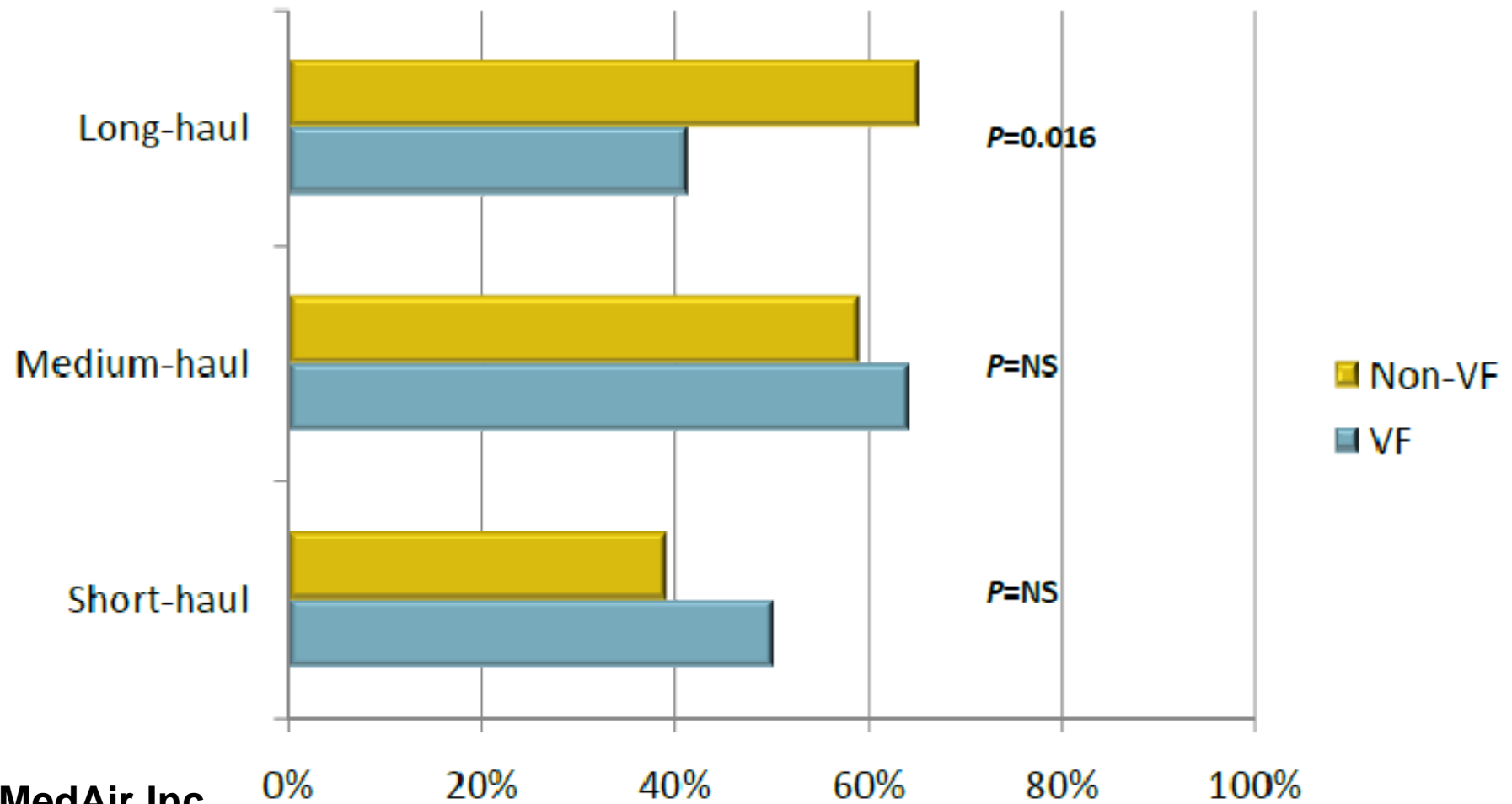
MedAir Inc.  
Dr. Paulo Alves

# Who operated the AED



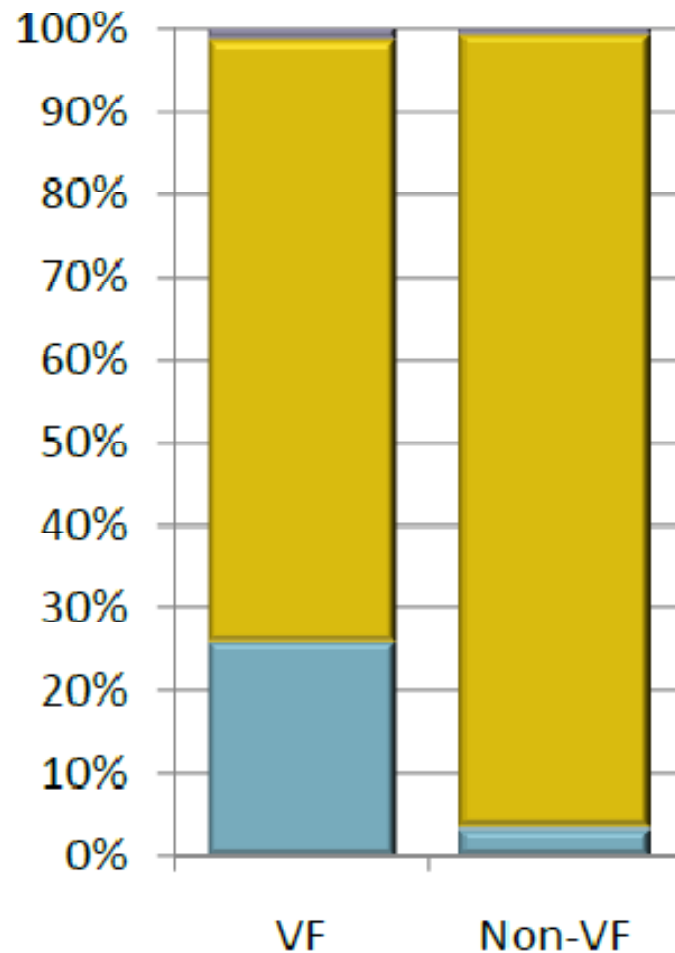
**MedAir Inc.**  
*Dr. Paulo Alves*

# Time of Occurrence as Percent of Flight



# Disposition

## VF vs. Non-VF (cases with TIF > 20 min)



■ Undetermined  
■ Expired  
■ Hospital

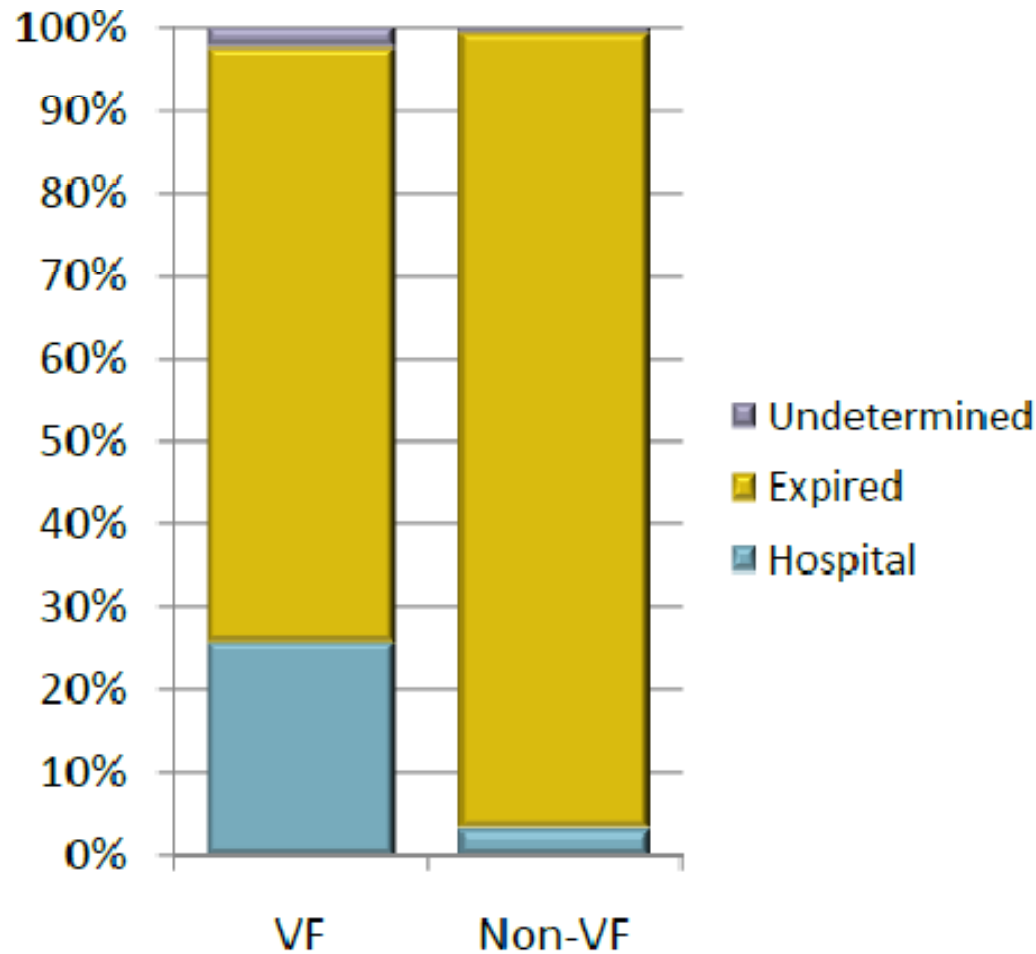
OR = 10.10  
3.88 < OR < 26.99  
P < 0.00001

**MedAir Inc.**  
*Dr. Paulo Alves*



# Disposition

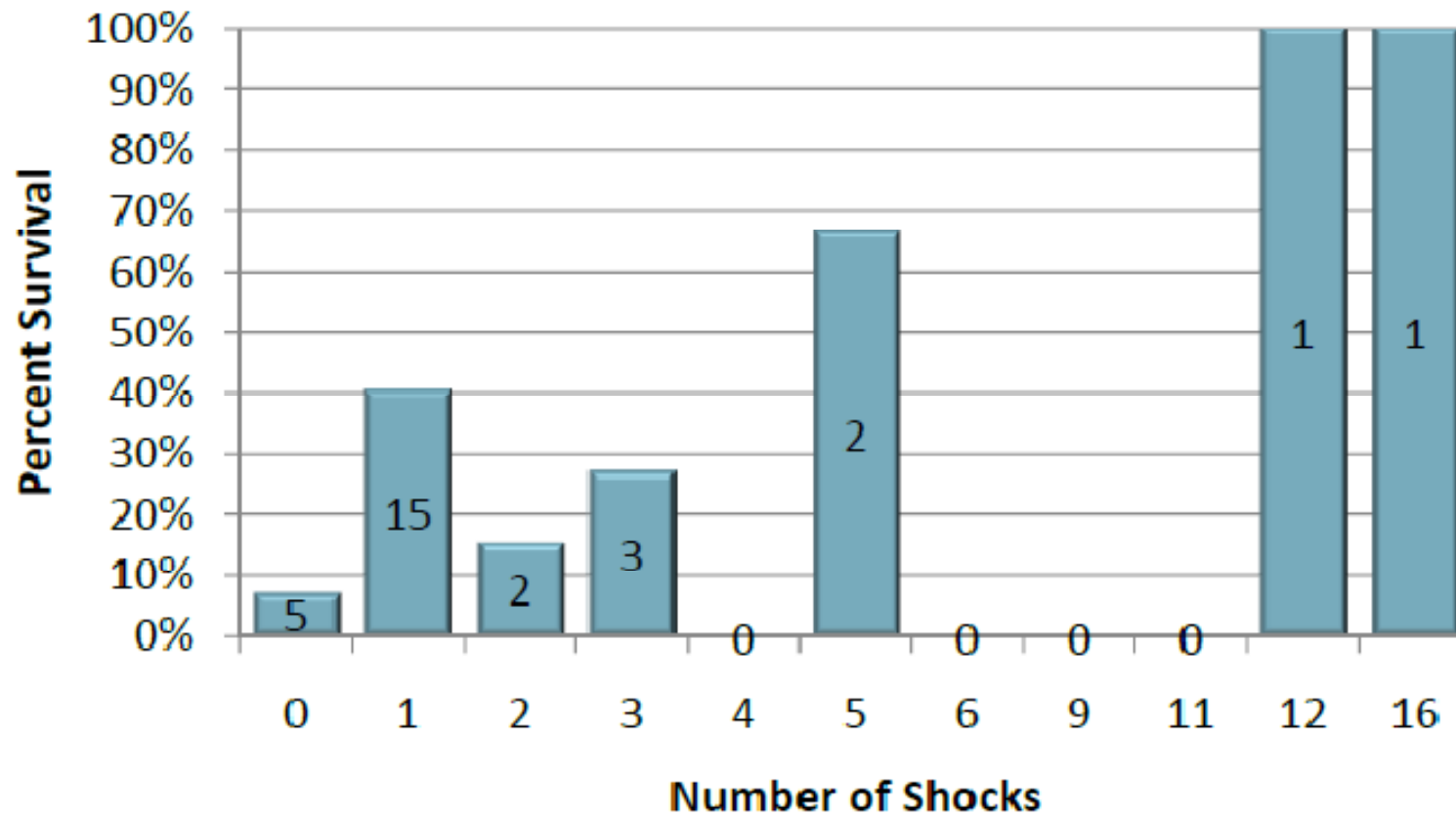
## VF vs. Non-VF (all cases)



OR = 10.94  
4.33 < OR < 28.46  
P < 0.00001

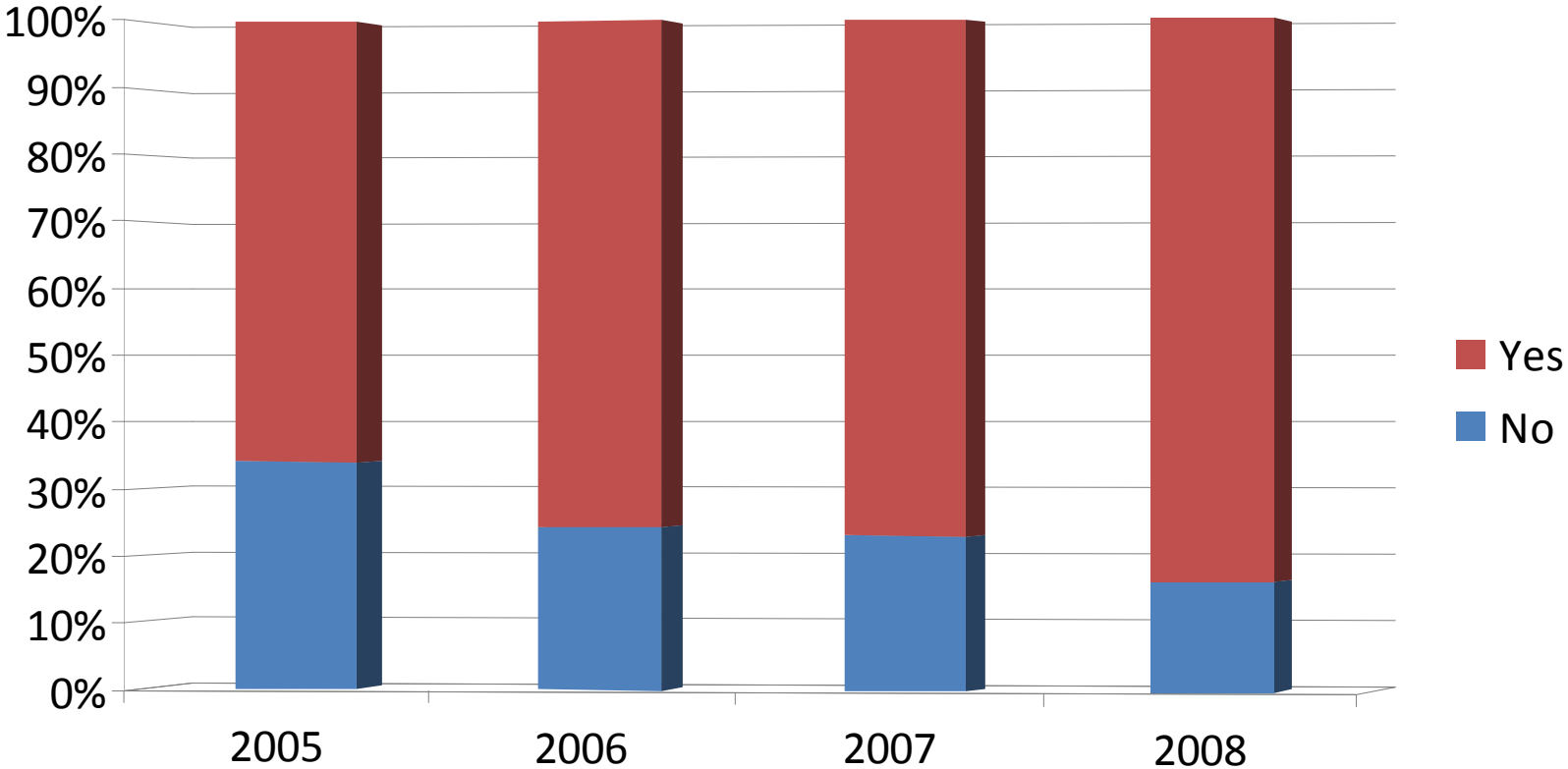
**MedAir Inc.**  
*Dr. Paulo Alves*

# Survival to Hospital vs. Number of Shocks



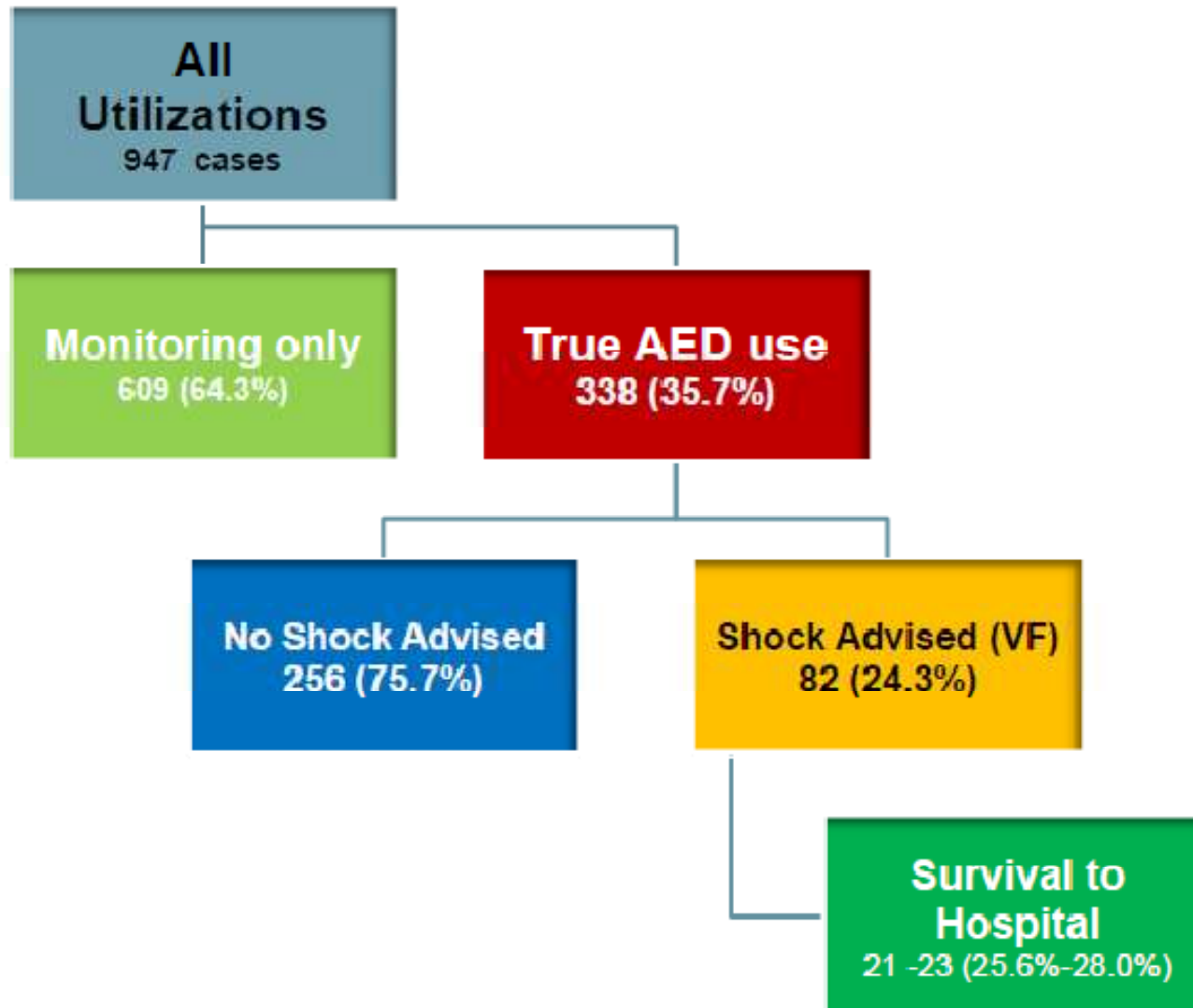
**MedAir Inc.**  
*Dr. Paulo Alves*

# Medical Personnel Aboard



**MedAir Inc.**  
*Dr. Paulo Alves*

# AED Utilization



**MedAir Inc.**  
*Dr. Paulo Alves*

# Conclusions

- VF is documented in 24.3% of IFCA cases
  - VF was relatively more frequent than non-VF in the first quarter of long-haul flights
- In most cases AED were operated by volunteer physicians
- Presence of VF significantly increased the chance for hospitalization after IFCA
- Survival to hospital rates in VF cases were 25.6%
  - Survival to hospital was 40% for those receiving one shock
  - 2 patients survived to hospital after receiving more than 10 shocks

# Pre-Flight Passenger Stresses

- Carrying luggage
- Walking long distances
- Flight delays or cancellations
- Inflight stresses include:
  - *Reduced barometric pressure and  $ppO_2$*
  - *Noise exposure*
  - *Vibration exposure*
  - *Turbulence*
  - *Uncomfortable temperatures and low humidity*
  - *Jet lag*
  - *Cramped seating and reduced mobility*

*General Guidance for Patient  
Acceptance for Airline Transport*

- As a general rule, an individual with an unstable medical condition should not fly
- Instability combined with the stresses of flight could pose a serious threat to the health and well-being of the sick or injured traveler



- Medical conditions assessed during a preflight medical evaluation include:
  - Cardiovascular disease (angina pectoris, congestive heart failure, myocardial infarction, deep venous thrombosis)
  - Asthma and emphysema
  - Surgical conditions
  - Seizure disorder
  - Stroke or CVA
  - Mental illness
  - Infectious diseases



Photo Copyright © William van Wanrooy

# Airline Acceptance of a Patient

- Passengers with special medical conditions that could lead to in-flight illness, injury, or risk to other passengers, may need a medical certificate from a health care provider stating that the passenger is currently stable and fit for air travel
- For a contagious disease, the certificate should also state that the passenger is not infectious



# Medical Oxygen



- Passengers are prohibited by most airlines from bringing onboard their own oxygen supply procured from an outside source
- Passengers who require oxygen should contact the airline as soon as possible in order to make arrangements for inflight oxygen
- Use of the emergency drop-down masks for therapeutic oxygen is prohibited by most airlines

# Medical Oxygen



If oxygen is required in the airport preflight, while waiting for connections, or on arrival, arrangements should be made with oxygen vendors (not the airline)

# Cardiovascular Indications for Medical Oxygen During Commercial Airline Flights

- Use of oxygen at baseline altitude
- Baseline PaO<sub>2</sub> less than 70 mm Hg
- Angina
- Cyanotic congenital heart disease
- Primary pulmonary hypertension
- Other cardiovascular diseases associated with known baseline hypoxemia





# Stretchers



- Airlines that allow the use of use of stretchers for ill passengers may require the purchase of as many as six seats (in the first or business class sections) and that an attendant travel with the passenger
- Airlines may also require that the stretcher conform with its specifications to meet safety regulations













# Inflight Medical Care



- Airlines train their flight attendants to recognize common symptoms of distress and to respond to medical emergencies with first-aid, basic resuscitation techniques, and the use of emergency medical oxygen
- The cabin crews might ask for assistance from onboard medical providers and will release the medical kit to providers with appropriate credentials
- An FAA study reported that physician travelers were available in 85% of reported inflight medical emergencies



TABLE I. FIRST-AID KITS.

According to the new rule for aircraft registered in the U.S. there must be 1-4 onboard first-aid kits depending upon the number of passenger seats. In general, each first-aid kit must contain the following:

Contents	Quantity
Adhesive bandage compresses, 1-inch	15
Antiseptic swabs	20
Ammonia inhalants	10
Bandage compresses, 4-inch	3
Triangular bandage compresses, 40-inch	5
Arm splint, noninflatable	1
Leg splint, noninflatable	1
Roller bandage, 4-inch	4
Adhesive tape, 1-inch standard roll	2
Bandage scissors	1

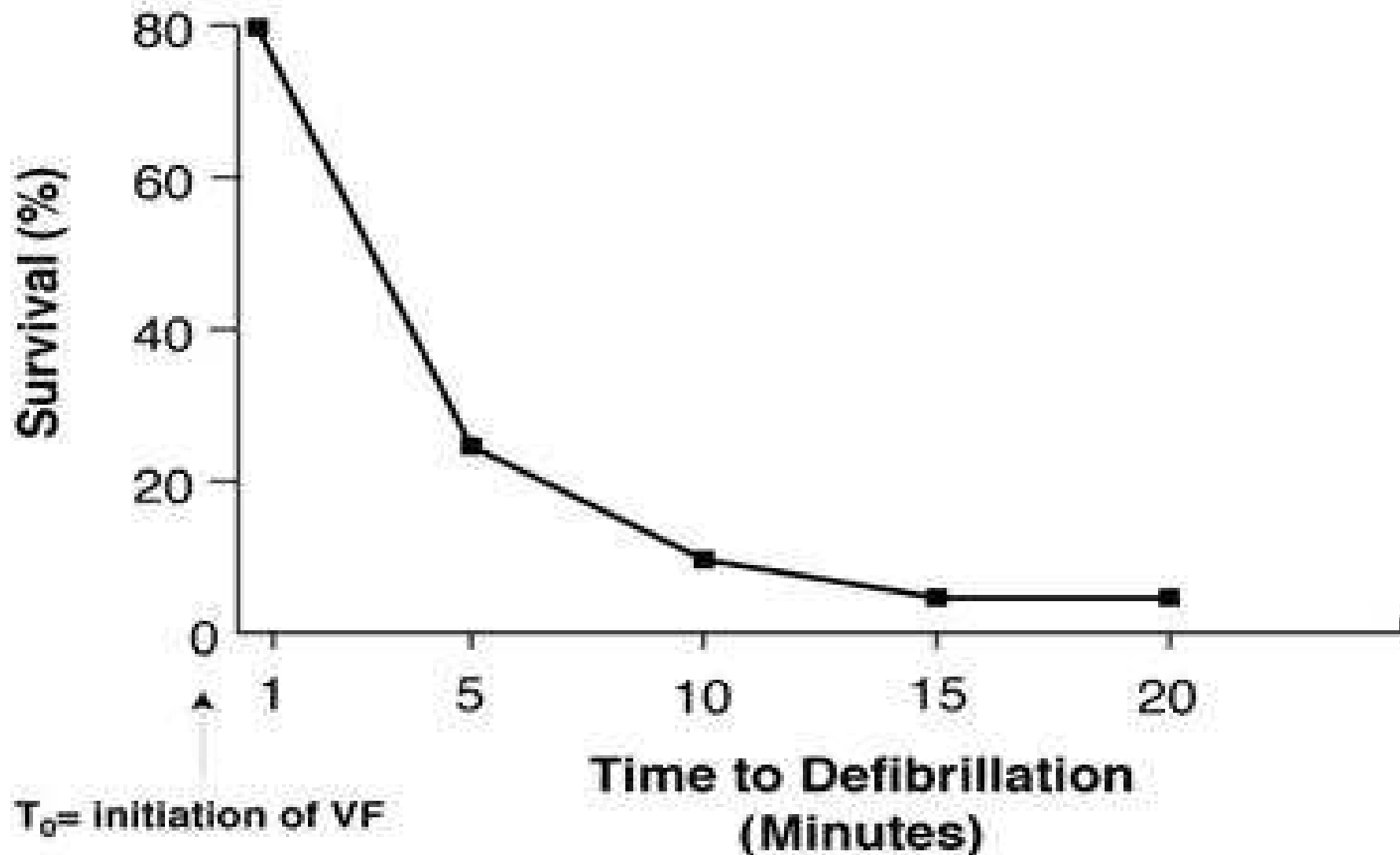
TABLE II. EMERGENCY MEDICAL KIT.

Contents	Quantity
Sphygmomanometer	1
Stethoscope	1
Airways, oropharyngeal (3 sizes): 1 pediatric, 1 small adult, 1 large adult or equivalent	3
Self-inflating manual resuscitation device with 3 masks (1 pediatric, 1 small adult, 1 large adult or equivalent)	3
CPR mask (3 sizes), 1 pediatric, 1 small adult, 1 large adult, or equivalent	3
IV Admin Set: Tubing w/2 Y connectors	1
Alcohol sponges	2
Adhesive tape, 1-inch standard roll adhesive	1
Tape scissors	1 pair
Tourniquet	1
Saline solution, 500 cc	1
Protective nonpermeable gloves or equivalent	1 pair
Needles (2-18 ga., 2-20 ga., 2-22 ga., or sizes necessary to administer required medications)	6
Syringes (1-5 cc, 2-10 cc, or sizes necessary to administer required medications)	4
Analgesic, non-narcotic, tablets, 325 mg	4
Antihistamine tablets, 25 mg	4
Antihistamine injectable, 50 mg, (single dose ampule or equivalent)	2
Atropine, 0.5 mg, 5 cc (single dose ampule or equivalent)	2
Aspirin tablets, 325 mg	4
Bronchodilator, inhaled (metered dose inhaler or equivalent)	4
Dextrose, 50%/50 cc injectable, (single dose ampule or equivalent)	1
Epinephrine 1:1000, 1 cc, injectable, (single dose ampule or equivalent)	2
Epinephrine 1:10,000, 2 cc, injectable, (single dose ampule or equivalent)	2
Lidocaine, 5 cc, 20 mg/ml, injectable (single dose ampule or equivalent)	2
Nitroglycerin tablets, 0.4 mg	10
Basic instructions for use of the drugs in the kit	1



The FAA has mandated that all US commercial aircraft with at least one flight attendant carry automated external defibrillators

## Importance of Early Defibrillation in Patients with Ventricular Fibrillation (VF)



- With the availability of trained flight attendants, onboard emergency medical kits, AEDs, inflight medical personnel, and/or ground medical consultants medical care inflight is almost always available if needed
- Nevertheless, an appropriate preflight evaluation of sick passengers is the key to prevention





**First Aid Kit**



**Defibrillator**

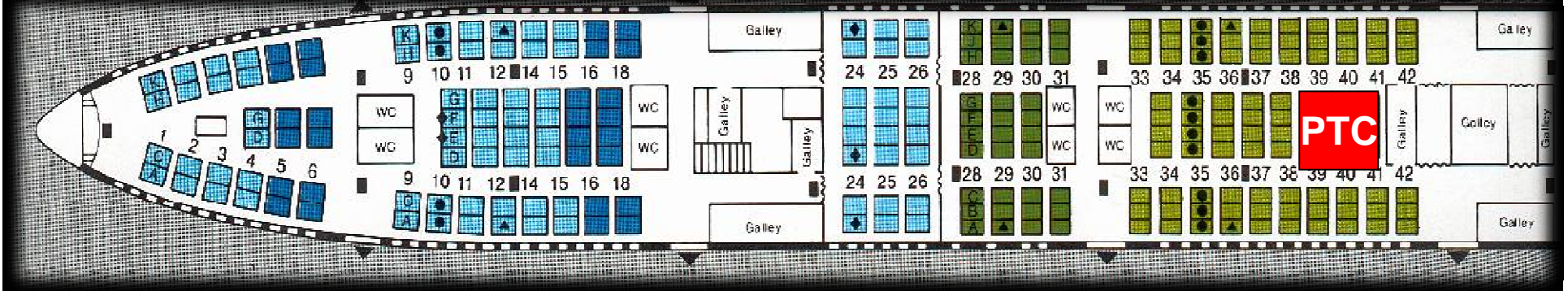


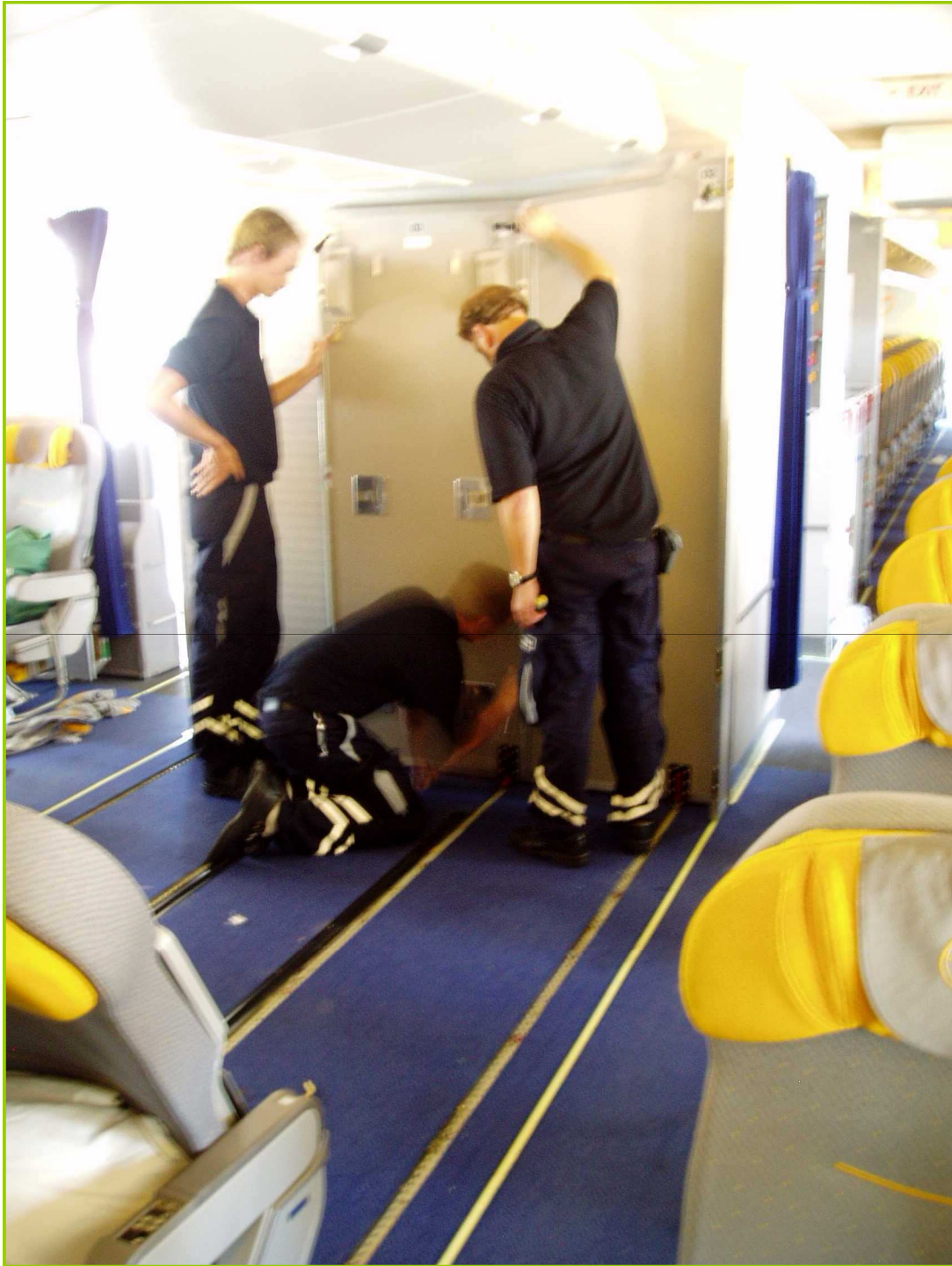
**Flight Attendant  
Medical Kit**



**Physician's Kit**









*Condition-Specific  
Medical Guidance*

# Surgery

- Postoperative patients are in a state of increased oxygen consumption due to the trauma of surgery, the possible presence of sepsis, and the increased adrenergic outflow
- Due to the decreased use of blood transfusions, many postoperative patients today are more anemic than in the past
- It is not uncommon to see younger patients with hemoglobins down to 7.0 g and elderly patients with values of 8.0 g

- Post-abdominal surgery patients have a relative ileus for several days that increases the risk for tearing of suture lines, bleeding, and perforation
- Stretching gastric or intestinal mucosa may result in hemorrhage from ulcer or suture sites
- Delay air travel for 1-2 weeks after the procedure
- Patients should not fly for 24 h following a colonoscopy with a polypectomy procedure because of the large amount of gas still often present in the colon





Source: Appl Radiol Online © 2003 Anderson Publishing, Ltd.

# ABDOMINAL BAROPATHY



Burping, flatulence, abdominal distension, abdominal pain, vagal syncope

Avoid consumption of gas forming food and drinks:  
Beans, chick-peas, lentels, drumhead cabbage, cauliflower, brussels sprouts, broccoli, pumpkin, turnips, onions, peppers, radish, melon, avocado, apples, wheat bread, carbonated drinks, etc.

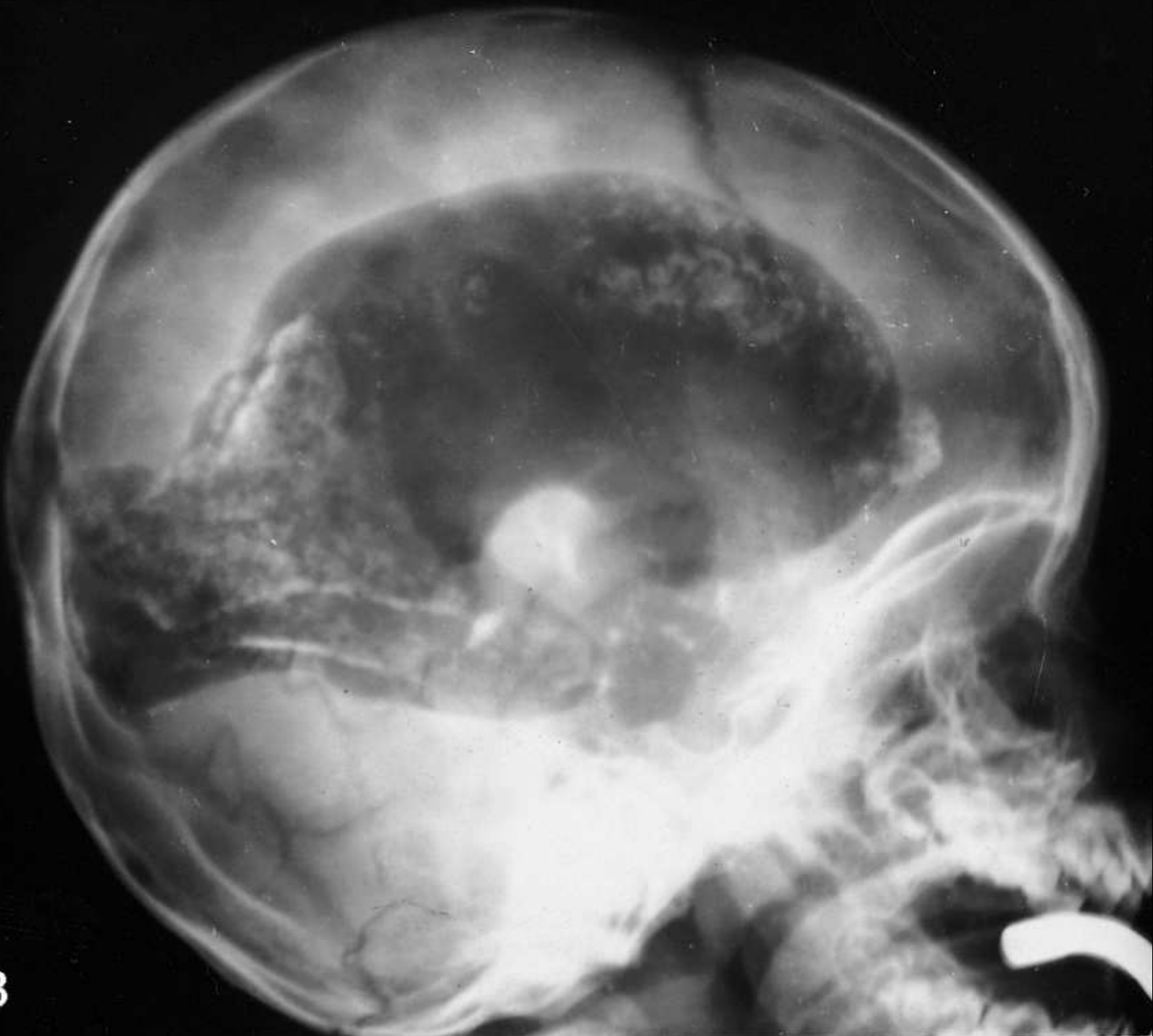
# Surgery

- Laparoscopic abdominal surgical procedures are less associated with ileus and patients can fly the next day if bloating symptoms are absent
- A patient with an asymptomatic partial small or large bowel obstruction should not fly due to gastrointestinal gas expansion
- The use of a large colostomy bag is recommended for passengers with colostomies

# Surgery

- Gas trapped within the skull will cause increased intracranial pressure when it expands at altitude (wait 7 days for air travel)
- Use a lateral skull film radiograph or CT scan to determine the presence of air in the skull
- A person with a cerebrospinal fluid leak from any cause should not fly because of the possibility of backflow and microbial contamination due to the pressure changes





B



Bubble

# Fractures



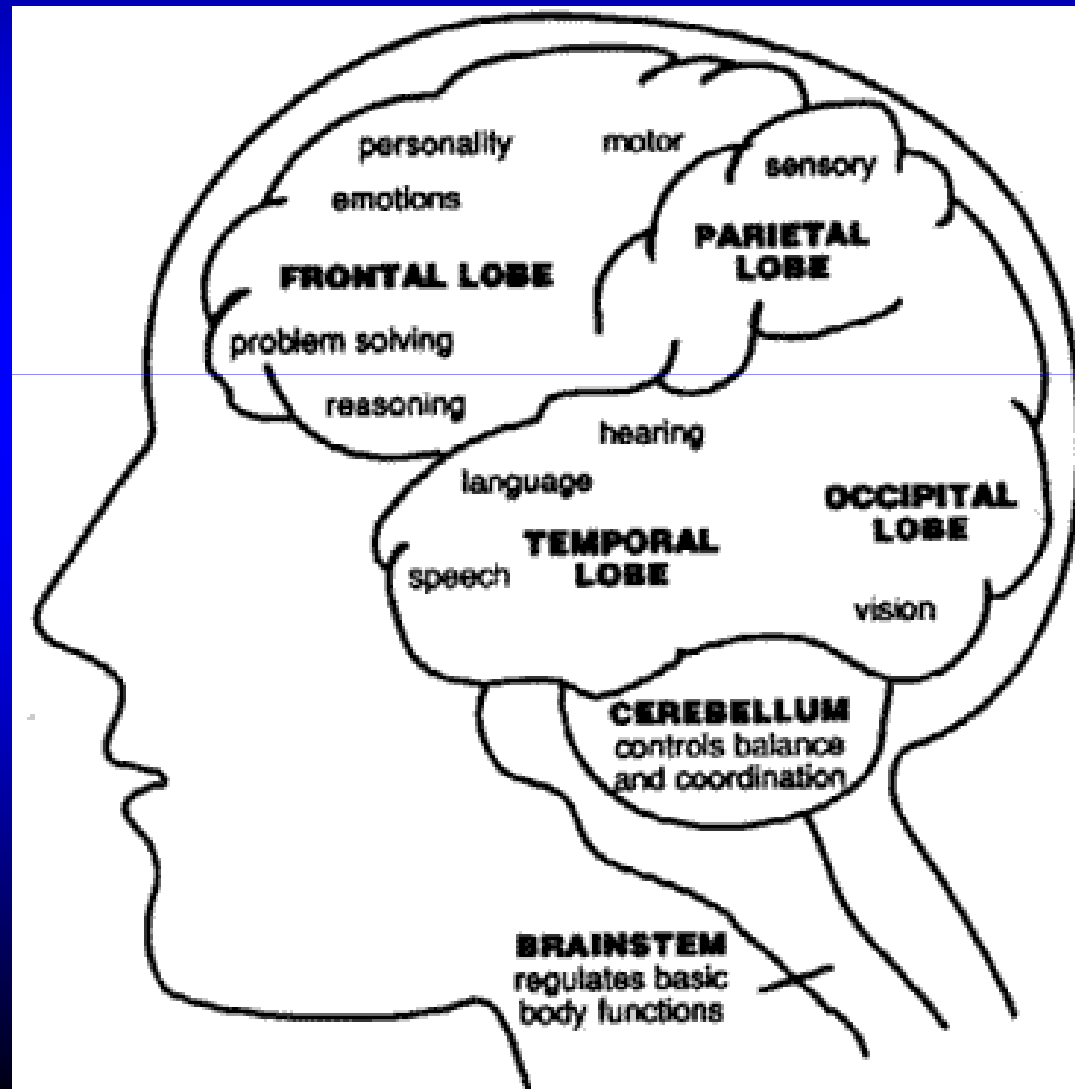
# Fractures

- Passengers with full-length above-knee casts are required by some airlines to travel by stretcher
- Airlines may require the purchase of an extra seat or seats, or alternatively to fly business or first class
- Because air might be trapped beneath the cast, it is advisable for casts applied within 24-48 hrs to be bivalved to avoid harmful swelling, particularly on long flights



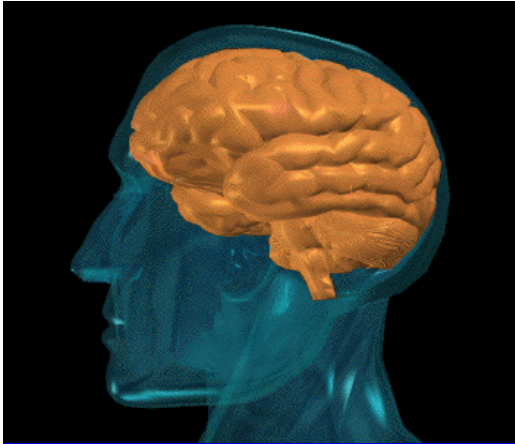


# NEUROLOGY



# Neurology

- Patients with uncontrolled, frequent seizures should be cautioned about air travel including the attendant risk of limited medical care capability inflight
- Individuals with seizures sufficiently frequent to cause immediate concern should consider traveling with a companion
- Patients with epilepsy should be made aware of the potential seizure threshold-lowering effects of fatigue, delayed meals, hypoxia, and disturbed circadian rhythm if passing through multiple time zones



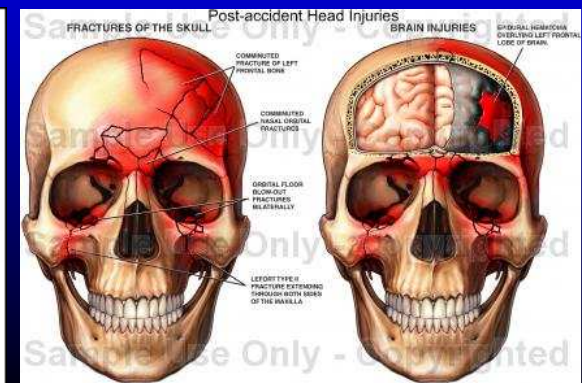
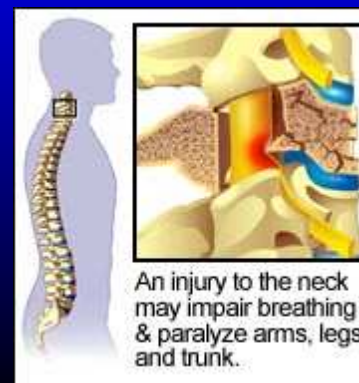
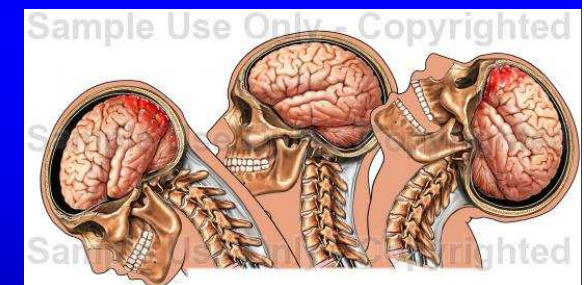
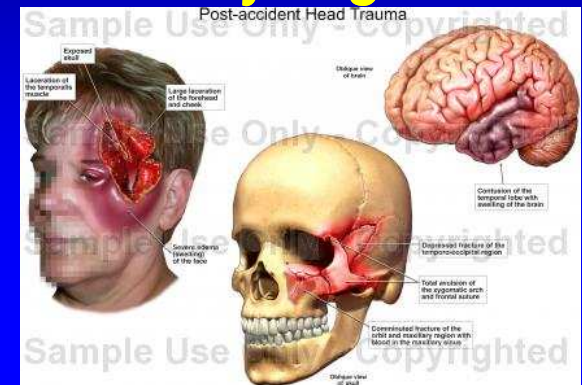
# Neurology

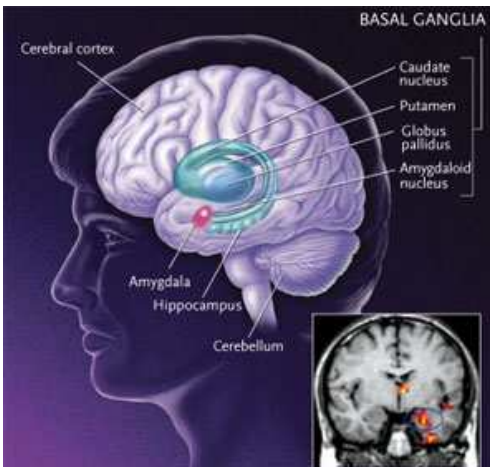
- Patients who have had a recent cerebral infarction (stroke) or other acute neurological event should be observed until sufficient time has passed to assure stability of the neurological condition
- The risk of post-event complications, the physical and mental disability, and the decreased capacity to withstand the stresses of flight are cogent reasons not to fly

# NEUROLOGY

## → Neurologic conditions that can be affected by flight:

- Increased intracranial pressure
- Open and closed- head injuries
- Neurogenic shock
- Spinal cord injuries
- Intra-cerebral hemorrhage
- Seizures
- Coma

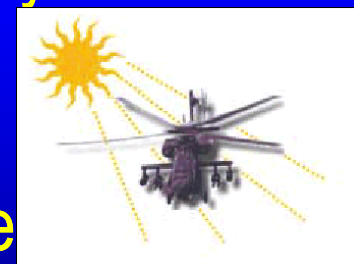




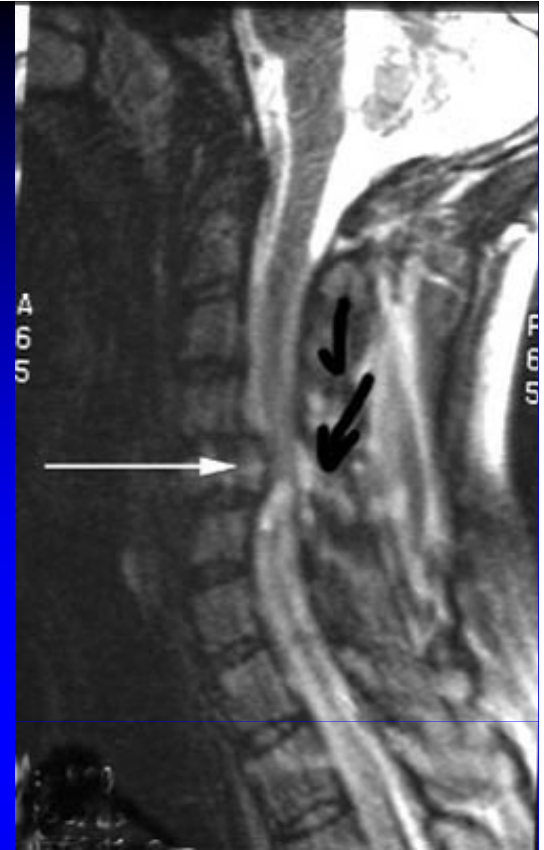
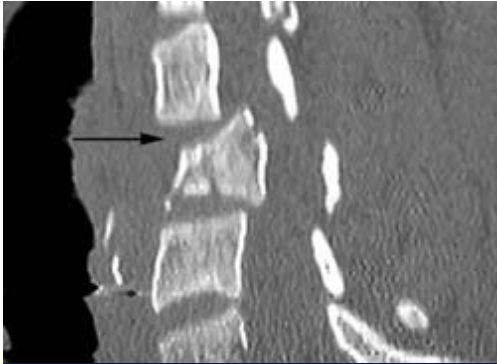
# NEUROLOGY

## → *Flight factors that can affect the neurologic patient*

- Hypoxia
- Gas expansion
- Dehydration
- Decreased Temperature
- Prolonged immobility
- Air Sickness
- Vibration and Noise
- G-Forces and Flicker Vertigo



# NEUROLOGY



## → *Suspect spinal injury with:*

- Multiple trauma
- Abnormal head tilting
- Facial fractures (especially mandibular)
- Spinal edema, tenderness or misalignment on palpation
- Paraesthesias of extremities

# NEUROLOGY



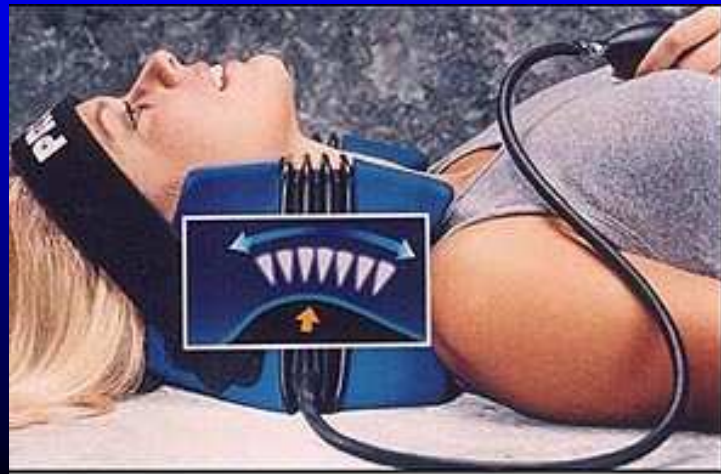
## → *Pre-Transportation Stabilization*

- Stabilization of the head and neck
- Stabilization of the spine





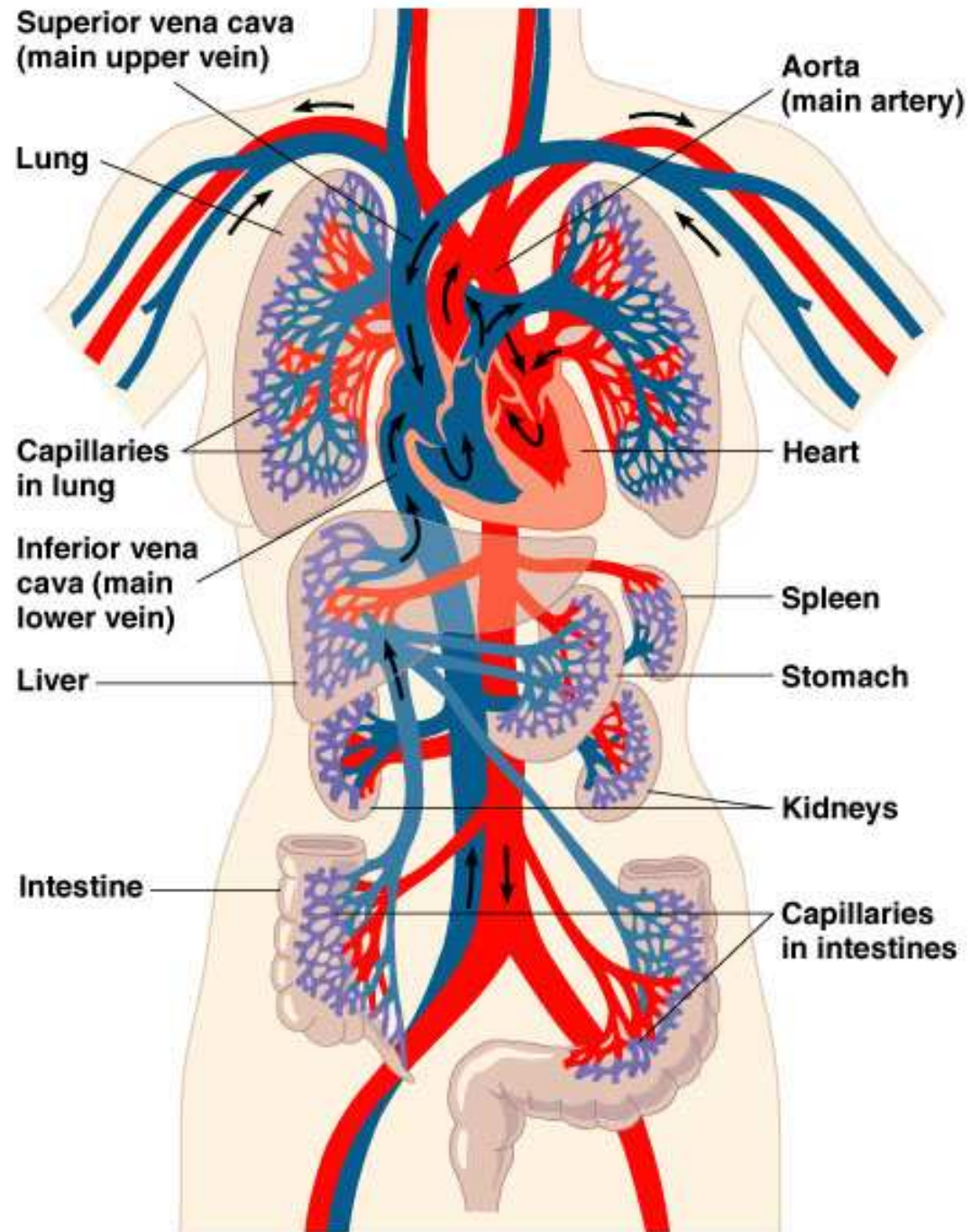


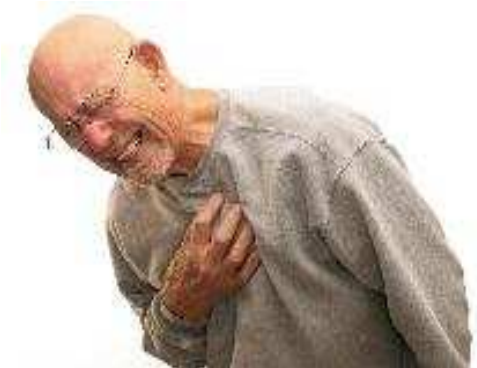


# NEUROLOGY

## → *Inflight Medical Care*

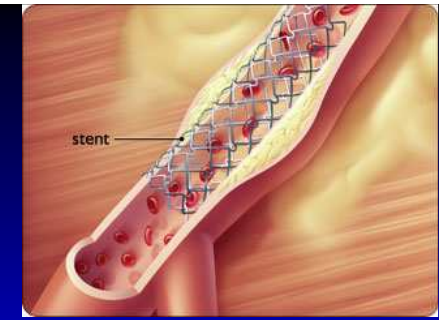
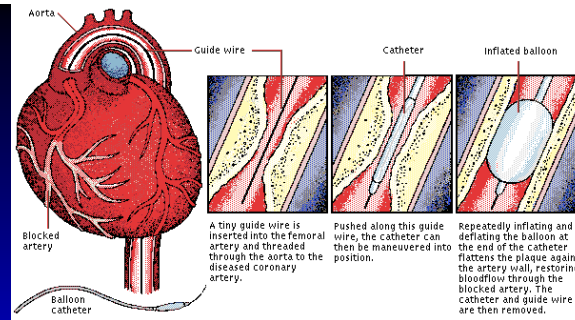
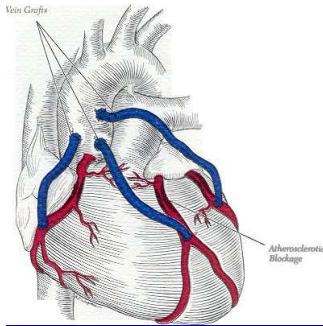
- Physical assessment: vital signs, respiratory status, peripheral pulses, neurologic status, adverse effects of altitude or stresses of flight
- Prevent increases in intracranial pressure by controlling: pain, anxiety, combativeness, turbulence, vibration, patient movement, ambient temperature, blood pressure, hydration, hyperventilation



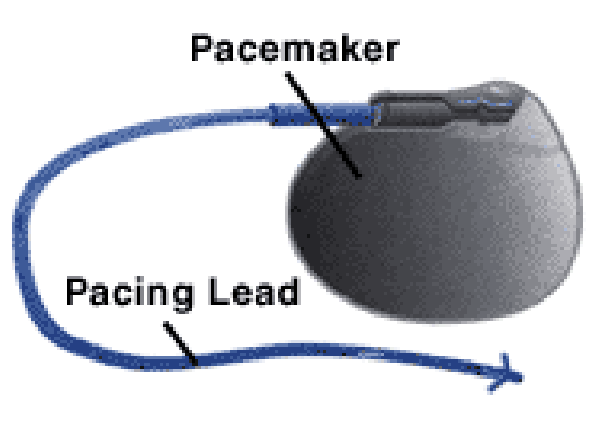


# Cardiovascular Pathology

- Most patients with angina pectoris can travel safely carrying their medications
- Patients with recent uncomplicated myocardial infarction (MI) should not fly until at least 2-3 weeks have passed and they are back to usual daily activities
- Patients with stable class III-IV Congestive Heart Failure or baseline PaO<sub>2</sub> less than 70 mmHg should receive inflight medical oxygen



- Coronary artery bypass grafting (CABG) and other chest surgeries should pose no risk as long as the patient has fully recovered without complications
- Because air is transiently introduced into the chest cavity, patients should wait until the air is resorbed (about 10-14 days) before flying
- Patients with uncomplicated percutaneous coronary interventions (PCI) such as angioplasty or stent placement, are at low risk to fly once they are medically stable and back to usual daily activities



- Patients with hypertension can fly as long as it is under control and they carry their medications
- Patients with pacemakers and implantable defibrillators are at low risk for travel by commercial airline once they are medically stable
- Interaction with airline electronics or airport security devices is highly unlikely for the most common bipolar configuration

# Cardiovascular Contraindications to Commercial Airline Flights

1. Uncomplicated myocardial infarction within 2-3 weeks
2. Complicated myocardial infarction within 6 weeks
3. Unstable angina
4. Congestive heart failure, severe, decompensated
5. Uncontrolled hypertension
6. CABG within 10 – 14 days
7. CVA within 2 weeks
8. Uncontrolled ventricular or supraventricular tachycardia
9. Eisenmenger syndrome
10. Severe symptomatic valvular heart disease

9. Ventricular septal defects and patent ductus arteriosus, which cause severe pulmonary hypertension





# Air Travel Recommendations for Cardiovascular Patients

1. Assure sufficient quantities of medications for the entire trip, including sublingual nitroglycerin, and keep in carry-on luggage
2. Keep a separate list of medications including dosing intervals and tablet size in the event that medications are lost
3. Adjust dosing intervals in order to maintain dosing frequency if crossing time zones
4. Carry a copy of the most recent ECG

5. Carry a pacemaker card, if a pacemaker patient
6. Contact the airline concerning special needs, e.g. diet, medical oxygen, wheelchair, etc., and consider special seat requests such as near the front or close to restroom
7. Limit unnecessary ambulation, particularly inflight. Consider curbside baggage check-in and arranging for a wheelchair or electric cart for in-airport transportation
8. Consider inflight medical oxygen if the patient has Canadian Cardiovascular Society class III-IV angina or baseline hypoxemia

# Deep Vein Thrombosis



- Deep vein thrombosis (DVT) is a condition in which a thrombus develops in the deep veins, usually of the leg
- The condition itself is not dangerous, but the complication of pulmonary embolism or venous thrombo-embolism (VTE) can be life threatening
- Up to 20% of the total population may have some degree of increased clotting tendency

# Factors that Increase the Likelihood of DVT

- Reduction in blood flow
- Changes in blood viscosity
- Damage or abnormality in the vessel wall



# Risk Factors for the Development of DVT

- Blood disorders affecting clotting tendency
- Impairment of blood clotting mechanism, such as clotting factor abnormality
- Cardiovascular disease
- Current or history of malignancy
- Recent major surgery
- Recent trauma to lower limbs or abdomen
- Personal or family history of DVT
- Pregnancy
- Estrogen hormone therapy, including oral contraception
- Age above 40 yr
- Prolonged immobilization
- Depletion of body fluids causing increased blood viscosity. (Note that this is not dehydration as a result of dry aircraft cabin air)

TABLE V. SUGGESTED DVT PROPHYLAXIS.

	Risk Categories	Prophylaxis
Low Risk	Age over 40; obesity; active inflammation; recent minor surgery (within last 3 days)	Advice about mobilization and hydration, $\pm$ support tights/non-elasticated long socks
Moderate Risk	Varicose veins; heart failure (uncontrolled); recent myocardial infarction (within 6 weeks); hormone therapy (including oral contraception); polycythemia; pregnancy/postnatal; lower limb paralysis; recent lower limb trauma (within 6 weeks)	Passenger advised to consult own medical practitioner who may recommend the above + aspirin (if no contraindication) $\pm$ graduated compression stockings
High Risk	Previous VTE; known thrombophilia; recent major surgery (within 6 weeks); previous CVA; malignancy; family history of VTE	As above, but passenger's medical practitioner may recommend low molecular weight heparin instead of aspirin

**Table 1**  
**Altitude Limits for Patients with Cardiorespiratory Disease  
 and No Oxygen Supplementation**

Altitude (Feet)	Condition
10,000	Cardiorespiratory disease suspected or symptomatic
8,000	Cardiorespiratory disease more than mildly symptomatic Marked ventilatory restriction
6,000	Recent myocardial infarction (8-24 weeks) Angina pectoris Sickle cell disease Alveolar block with cyanosis Patients with: Clinical cyanosis Core pulmonale Respiratory acidosis
4,000	Severe cardiac disease with cyanosis or recent decompensation Patients with any two: Clinical cyanosis Core pulmonale Respiratory acidosis
2,000	Cardiac patients with failure. Recent myocardial infarction (8 weeks) Patients with all three: Clinical cyanosis Core pulmonale Respiratory acidosis

*From American College of Chest Physicians, Committee on Physiologic Therapy, Section on Aviation Medicine. Air travel in cardiorespiratory disease. Dis Chest 37. 1969:579-588.*

# Airsickness



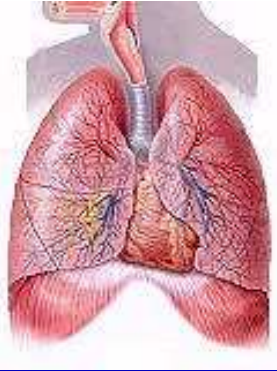


# Airsickness

- Prevent with oral medications such as phenergan with ephedrine, hyocine, dextroamphetamine, or with a transdermal scopolamine patch worn behind the ear
- Susceptible individuals should avoid excess liquids, high fat, spicy or gas-forming foods, and sit close to the wing
- Even small amounts of alcohol can increase sensitivity of the vestibular system
- Susceptible individuals should avoid alcohol for 24 h prior to as well as during flight

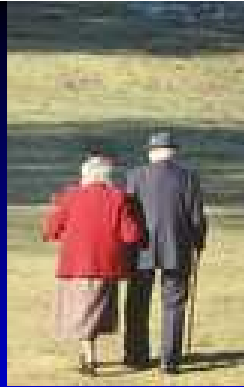
# *Pulmonary*





# Pulmonary Pathology

- The physician's advice to pulmonary patients who intend to fly depends largely on:
  - 1) Type, reversibility, and functional severity of the pulmonary disorder
  - 2) Evaluation of altitude tolerance and safety for the patient
  - 3) Anticipated altitude and duration of the flight
- In patients with significant cardiopulmonary disease, even a small degree of hypoxia may lead to problems correctable by medical oxygen



- The single most practical fitness-to-fly test for a physician is to see whether the patient can walk 50 yards at a normal pace or climb one flight of stairs without becoming dyspneic
- The physician's judgment should also reflect the altitude of the departure airport, length of journey, destination, and history of prior air travel
- Simple measures to assist passengers include early unhurried arrival and check-in, provision of wheel chairs, and avoidance of seating in smoking zones



# Pulmonary Pathology

- The majority of inflight medical oxygen requests are for chronic respiratory disorders such as:
  - Bronchitis
  - Emphysema
  - Bronchiectasis
  - Pulmonary hypertension

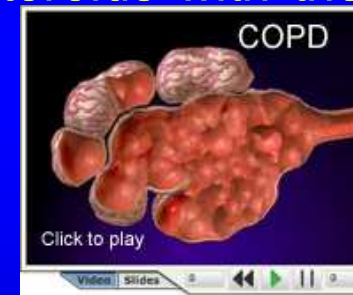
- Asthma:



- Air travel is contraindicated for those with asthma that is labile, severe, or that has required recent hospitalization
- Patients must carry on board any vital medication, particularly inhalers for rapid relief of symptoms
- Advise patients to take a course of oral steroids with them for use in an emergency during the trip

- Chronic Obstructive Pulmonary Disease:

- Patients with chronic bronchitis and emphysema are susceptible to significant in-flight hypoxemia, depending on their baseline PaO<sub>2</sub>
- Medical oxygen therapy during flight can be an important adjunct to their safety and comfort

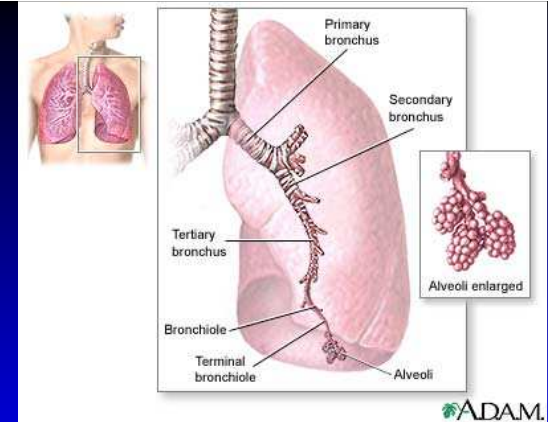


- Bronchiectasis and Cystic Fibrosis:

- Control of lung infection and measures to effectively loosen and clear secretions are important aspects of medical care on the ground and during travel
- Antibiotic therapy, adequate hydration, effective cough and medical oxygen therapy are essential for both conditions

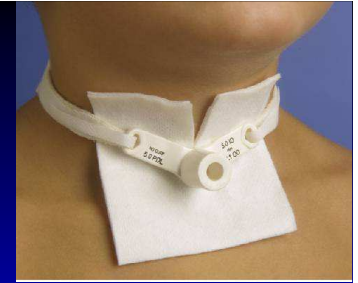
- Interstitial Lung Disease:

- Patients with idiopathic pulmonary fibrosis and sarcoidosis can generally tolerate air travel.
- Medical oxygen may be necessary in those patients with severe disease



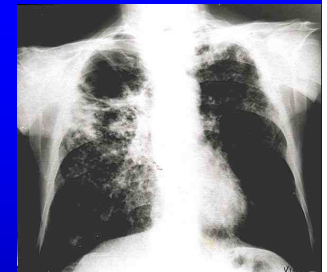
- Neuromuscular Diseases:

- Patients with spinal cord injuries, obesity, hypoventilation syndrome, kyphoscoliosis, muscular dystrophy, and other types of neuromuscular disorders have limited ability to hyperventilate and clear secretions
- Patients with tracheostomy and/or some form of mechanical ventilator may fly, but often require some manual assistance, suctioning or ventilator capabilities, and medical oxygen



- Pulmonary Infections:

- Patients with active or contagious respiratory infections, particularly pulmonary tuberculosis, are unsuitable for air travel until there is control of the infection (i.e., negative cultures) and clinical improvement







- Pneumothorax:

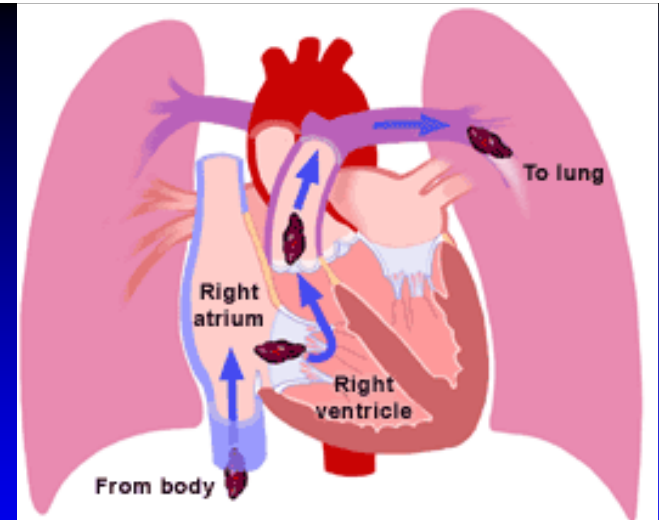
- Pneumothorax is an absolute contraindication to air travel since it may expand during flight and possibly progress to a tension pneumothorax
- It should be safe to travel by air 2 or 3 weeks after successful drainage of a pneumothorax
- Stable patients with a persistent bronchopleural fistula can fly safely with a chest tube using a one-way Heimlich valve assembly
- Lung cysts or bullae are usually not a problem as long as the airways communicate with the abnormal air collection

- Pleural Effusion:

- A pleural effusion should be drained at least 14 days prior to flight for both diagnostic and therapeutic reasons



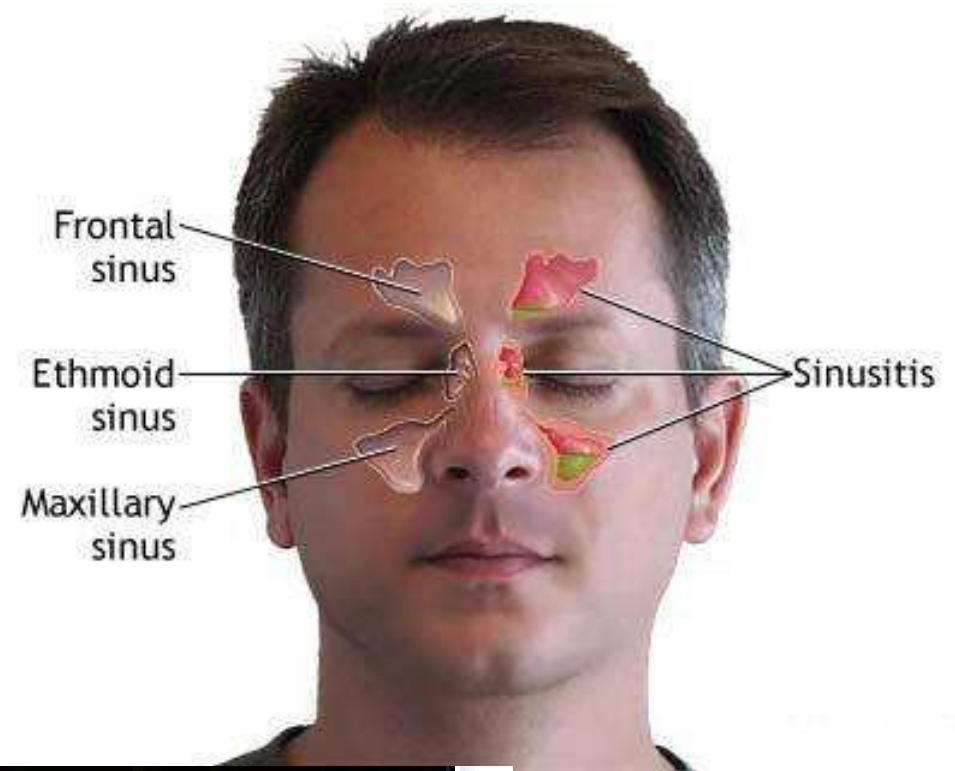
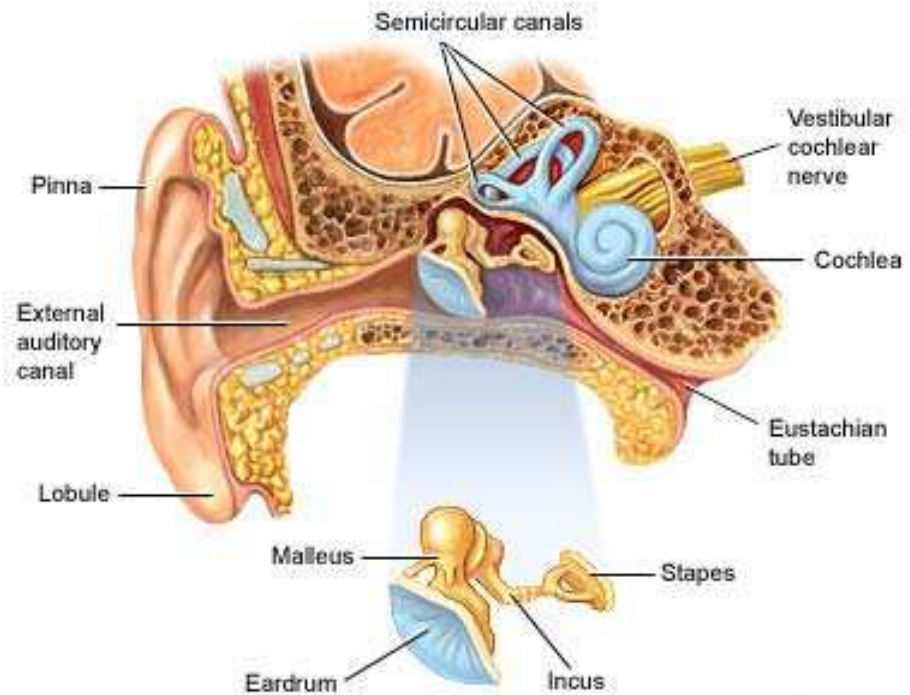
- Pulmonary Vascular Diseases:



- Patients with pulmonary embolism or pulmonary hypertension are at risk for hypoxia-induced pulmonary vasoconstriction during air travel
- Anticoagulation, medical oxygen, and restricted exercise during flight may reduce this risk
- The immobilization related to long flights may predispose some patients to thrombophlebitis and pulmonary embolism
- Isometric exercises of the lower extremities and support hose are highly recommended

- Special Conditions:

- Patients with tracheostomy or transtracheal oxygen catheters produce increased respiratory secretions
- The low humidity in aircraft cabins tends to exacerbate this problem
- Humidification of inspired air (or oxygen), adequate hydration, and suctioning can reverse some of the effects of mucus hypersecretion and dry air
- Changes in atmospheric pressure may expand trapped gases within the lung or pleural space, resulting in structural changes that may affect cardiopulmonary function and gas exchange
- A chest radiograph is a useful preflight test to exclude pneumothorax, pneumonia, and other acute abnormalities, if suspected



ADAM.



(CNN)

# Ear, Nose and Throat

- Passengers with middle ear infections, effusions, recent surgical procedures (tympanoplasty, mastoidectomy, stapedectomy, endolymphatic shunt, labyrinthectomy, acoustic neuroma removal, nerve section via middle cranial fossa, or other otologic surgery) should not fly
- Ear tube placement or myringotomy help ventilate the middle ear can be flown if no active discharge or obstruction is present
- The key to preventing blockage, hearing loss, tinnitus, pain, tympanic membrane rupture, or dizziness is to equalize the pressure

- Children should be kept awake during descent
- Upright bottle-feeding, pacifier use, eating, or crying all help eustachian tube function
- The external auditory canal, if obstructed by nonventilated earplugs, hearing aids, severe cerumen impactions or ear infections, can be painful
- Patients with hearing aids should turn their hearing aid down, because volume increase merely reduces discrimination due to background noise in the cabin

- Passengers with acute or chronic sinusitis, large polyps, recent nasal surgery, recurrent epistaxis and significant upper respiratory tract infections should not fly
- Broad-spectrum antibiotic therapy, mucolytic agents, oral decongestants, steroids, and temporary use of nasal decongestant spray help provide temporary sinus ventilation and drainage
- Passengers with nasal allergies should be treated with antihistamines, topical nasal steroids and, in some cases, immunotherapy





- Passengers with old tracheotomy, laryngectomy, vocal cord paralysis or other laryngeal dysfunction may need extra moisturization and possibly removal of thickened secretions due to lower humidity inflight
- Following tonsillectomy and adenoidectomy, palatoplasty, or nasal or facial fracture repair, patients can fly after about 2 weeks
- Patients with facial plastic surgical procedures such as facelift, blepharoplasty, otoplasty, peels, rhinoplasty, implants, or dermabrasion can fly once drains are removed and they are cleared by their surgeon (within 1-2 weeks)

# Psychiatry





# Psychiatry



- Patients with some psychiatric disorders become very upset by changes to familiar routines, confusion over procedures, enforced crowding with strangers, or lack of privacy
- Persons with psychiatric disorders whose behavior is unpredictable, aggressive, disorganized, disruptive or unsafe should not travel by air
- Patients with psychotic disorders who are stabilized on medication and are accompanied by a knowledgeable companion may be able to fly



# Psychiatry



- Physicians should be alert for tendencies toward claustrophobia and phobias about air travel or interpersonal crowding
- An anxiolytic medication may be indicated if the patient has used it before with good results and without undue side effects
- Fully detoxify patients diagnosed with drug or alcohol abuse before they travel, in order to avoid in-flight withdrawal reactions



# Psychiatry



- Some patients who function reasonably well during daylight hours in familiar settings (e.g., with early to moderate Alzheimer's disease) may become progressively upset, disoriented and agitated in strange or over-stimulating surroundings, or during the hours of darkness



# *Combative Patients*



- Combative psychiatric patients can be a serious threat to the safety of flight personnel
- Inflight noise, vibration, hypoxia and confined space can provoke or increase combative behavior
- Combativeness can be caused by psychosis, head or CNS injuries, hypoxia, alcohol intoxication or withdrawal



# *Combative Patients*



## → *Predictors of violent or combative behavior:*

- Acute psychotic crisis
- Organic brain syndrome
- Post-seizure states
- Antisocial personalities
- Chemical poisoning
- Severe claustrophobia
- Fear of heights (acrophobia) or flying (avio-phobia)

# Restraints



## → *Indications for physical restraint prior to transport:*

- Combativeness history
- Patient's activities interfere with medical care
- All unconscious patients
- Patients with weapons
- Prisoners





# Physical Restraints



## → *Types of physical restraints:*

- Rayon webbing
- Leather restraining straps
- Polyethylene cable ties
- Handcuffs



## → *Precautions:*

- Prevent limb injuries
- Do not pad restraints





# Pharmacological Restraints



## → **Pharmacological restraints:**

- Antipsychotics
- Tranquilizers (benzodiazepines and narcotics)
- Neuromuscular blocking agents

## → **General precautions:**

- Medications can depress respiration
- Monitor breathing during flight

# Psychiatry

## → *Patient care inflight:*

- Do not load or unload the patient in a hurry
- Speak softly to the patient
- Cover patient's ears with a headset or ear plugs
- Do not invade patient's personal space
- Land immediately if patient cannot be controlled



# Diabetes

- Overseas travel should not pose significant problems for air travelers with well controlled diabetes mellitus
- The diabetic must carry adequate equipment, e.g., blood-sugar testing sticks, blood glucose meter and insulin supplies, in case these are not available in the destination
- Those who are being treated with insulin should carry an ample supply in their hand luggage

# Diabetes

TABLE VI. INSULIN ADJUSTMENT WHEN TRAVELING EAST ACROSS MULTIPLE TIME ZONES.

Usual Regimen	Day of Departure/Travel (East bound)		First Day at Destination	
Multiple injection regimen with pre-meal soluble insulin and overnight intermediate insulin.	Usual premeal soluble insulin. If less than 4 hours between meals this requires a slightly reduced dose of the third soluble injection (by 1/3) and additional carbohydrate (ie. extra large evening snack if one meal missed) and a reduction (1/3) in overnight intermediate insulin to avoid nocturnal hypoglycemia.		Return to usual insulin regimen if you have overcompensated with the reduction of the evening intermediate insulin. Additional soluble insulin (1/3 of usual morning dose) should be considered if fasting blood glucose $> 14 \text{ mmol} \cdot \text{L}^{-1}$ ( $250 \text{ mg} \cdot \text{dl}^{-1}$ ).	
	Day of Departure	First Morning at Destination	10 hr After Morning Dose	Second Day at Destination
Two-dose schedule	Usual morning and evening doses	2/3 usual morning dose	Usual evening dose plus remaining 1/3 of morning dose if blood sugar over $14 \text{ mmol} \cdot \text{L}^{-1}$ ( $250 \text{ mg} \cdot \text{dl}^{-1}$ )	Usual two doses
Single-dose schedule	Usual Dose	2/3 usual dose	Remaining 1/3 of morning dose if blood sugar over $14 \text{ mmol} \cdot \text{L}^{-1}$	Usual dose

# Diabetes

TABLE VII. INSULIN ADJUSTMENT WHEN TRAVELING WEST ACROSS MULTIPLE TIME ZONES.

Usual regimen	Day of Departure/Travel (West Bound)		First Day at Destination
Multiple injection regimen with pre-meal soluble insulin and overnight intermediate insulin.	Usual premeal soluble insulin. Additional soluble insulin injection with additional meal/snack. Modest reduction (1/3) in overnight intermediate insulin to avoid nocturnal hypoglycemia.		Return to usual insulin regimen. Additional soluble insulin (1/3 of usual morning dose) should be considered if fasting blood glucose $> 14 \text{ mmol} \cdot \text{L}^{-1}$ ( $250 \text{ mg} \cdot \text{dl}^{-1}$ ).
	Day of Departure	18 hour After Morning Dose	First Morning at Destination
Two-dose schedule	Usual morning and evening doses	1/3 usual dose followed by meal or snack if blood glucose $> 14 \text{ mmol} \cdot \text{L}^{-1}$	Usual two doses
Single-dose schedule	Usual dose	1/3 usual dose followed by meal or snack if blood glucose $> 14 \text{ mmol} \cdot \text{L}^{-1}$	Usual dose

# Ophthalmologic Conditions



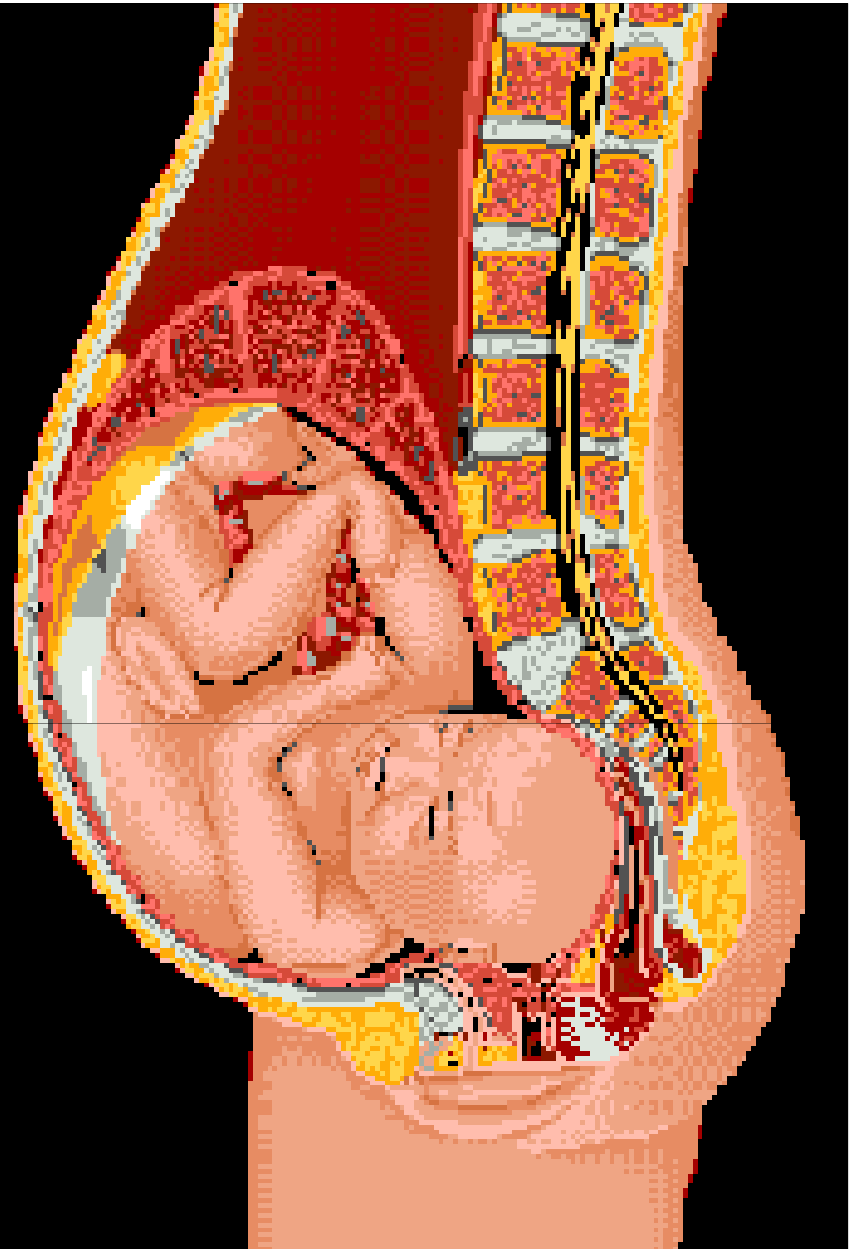
# Ophthalmologic Conditions

- Ophthalmological procedures for retinal detachment involve the intraocular injection of gas to temporarily increase intraocular pressure
- Until the intraocular bubble decreases to less than 30% of the volume of the vitreous, flight is contraindicated
- To minimize the risk of trauma to the eye by limiting movement in the cabin and keeping the seat belt fastened at all times when seated is advisable after any ophthalmological surgical procedure



# Ophthalmologic Conditions

- The passenger who becomes easily airsick should not travel immediately after intraocular eye surgery, since the straining associated with retching and vomiting might rupture a wound
- Passengers with severely limited vision may need special assistance boarding and deplaning, and should be seated close to, but not at an emergency exit



# Pregnancy and Air Travel

- The commercial aircraft environment is not generally considered hazardous to the normal pregnancy
- Air travel is a much safer and more comfortable mode of transportation during pregnancy when compared to most alternatives
- Chronic exposure in either commercial aircraft or living at 10,170 ft (3100 m) does not cause significant pregnancy-related problems (*some airlines allow pregnant flight attendants and pilots to fly through the first 2 trimesters*)

- Increasing altitude results in expansion of gas trapped in body cavities
- Intestinal gas expansion could cause additional discomfort in late pregnancy due to abdominal crowding (avoid gas-producing food)
- Nausea and vomiting occurring in early pregnancy may be increased during flight due to motion sickness
- Pregnant women should use their seat belts while seated with the lap belt worn snugly over the pelvis or upper thighs to reduce the potential for injury of abdominal contents

- Because aircraft seating is cramped and passengers remain immobile for long periods, there is the risk of lower extremity edema, thrombophlebitis, and DVT
- Pregnancy increases this risk due to obstruction of the vena cava from uterine compression, dependent lower extremities, and altered clotting factors
- It is vital that pregnant flyers ambulate every hour or two and constricting garments must be avoided
- Request an aisle seat for easier ingress, egress, and periodic leg stretching

- Pregnancy-related emergencies are most likely in the first and third trimester
- Approximately 15–25% of pregnancies end in spontaneous abortion with a rate of 12% for those less than 20 yr of age to over 25% for those over 40
- About 1 in every 80 pregnancies is ectopic and is associated with a 10-fold increased risk of maternal mortality over normal delivery
- It is advisable that pregnant women (particularly in the 1st trimester) not initiate a flight if they are having bleeding or pain

- Women with multiple pregnancies, a history of pre-term delivery, cervical incompetence, bleeding, or increased uterine activity that might result in early delivery should avoid prolonged air travel
- Individuals with reduced oxygen carrying capacity of the blood, such as anemia, should be treated prior to flight
- Intrauterine growth retardation, post maturity, preeclampsia, chronic hypertension, or placental infarction may result in reduced placental respiratory reserve and may preclude flight or necessitate medical oxygen therapy





# Flying with Children

- Infants and toddlers have poor eustachian tube function and often have bouts of otitis media that can increase the risk of otalgia during descent
- It is helpful to have a baby nurse a bottle or breast or suck a pacifier to open the eustachian tube
- Children with upper respiratory infections and congestion may benefit from a nasal decongestant given 30 min prior to descent
- Otitis media is not thought to preclude flight if appropriate antibiotics have been administered for at least 36 h and the eustachian tube is patent



