

Medical Implications of Air Travel:

How to Help Your Patient Travel Safely Through the Atmosphere and into Space

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Learning objectives:

After this talk the participant shall be able to:

1. Review the physiology of the flight environment and the emanating risks for passengers and aircrew.
2. Review common medical conditions and their aeromedical assessment
3. Counsel patients with the common inquiries pertaining to the cabin environment

Clinical Issues in Aerospace Medicine

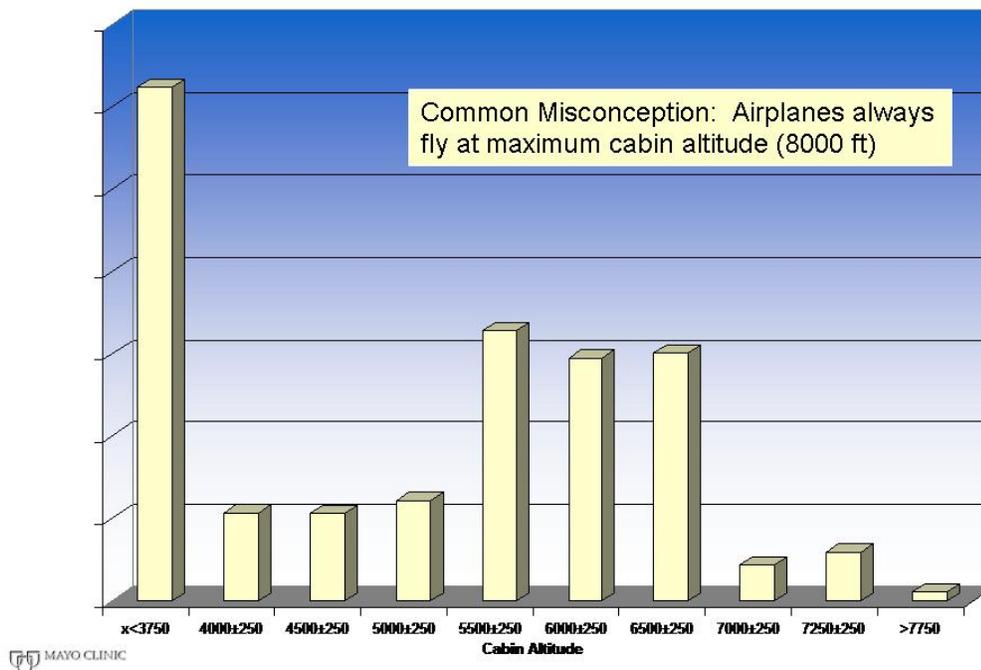
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Many of our patients travel by air. They are exposed to an environment with many significant physiologic changes and challenges. The following is a list of the main environmental stressors they will encounter during air travel: ¹

1. airport environment (long walking distances between gates, fatigue, tension / anxiety due to heightened security measures)
2. decreased barometric pressure (aircraft pressure cabin may reach an altitude of 2438m (8000ft))
3. reduced oxygen supply due to decreased ambient pressure (Pa_{O_2} at sea level is 95 mmHg; Pa_{O_2} at 2438m (8,000 ft) is 68 mmHg)
4. low humidity in flight
5. restricted opportunity for movement (need for prolonged sitting)
6. vibration & noise
7. circadian dyssynchrony ("Jet lag") due to crossing of time zones

Exposure to altitude results in gas expansion due to Boyle' law. Gas expands approximately 25% when ascending from sea level to 2438 m. This has clinical relevance for trapped gases in the sinus, middle ear, gastrointestinal tract, and for postoperative gas residues.

Weighted distribution of Cabin Altitudes



According to Dalton's law, the passenger will experience mild hypobaric hypoxia due to the decreased partial pressure of oxygen (160 mmHg at sea level; 119 mmHg at 2438m). The resulting hypoxia is mild and easily tolerated by a healthy person, but may become clinically relevant for a patient with borderline cardiopulmonary reserves.

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It is not uncommon to be asked to determine whether a patient is fit to fly on a commercial or private flight. Patients with unstable medical conditions should generally be discouraged from flying.

A good initial assessment consists of observing a patient walk 50 yards on a level surface or climb one flight of stairs. Excessive dyspnea with either warrants further assessment, such as arterial blood gas (ABG) determination, FEV1, FEV1/FVC or even a high altitude simulation test (HAST, breathing a mixture of 15% O₂ and 85% N₂ with a subsequent determination of ABGs). If a HAST reveals a PaO₂ of less than 55 mmHg, then medical oxygen is indicated in flight .²

The duration of travel, cabin altitude (pressurized cabin or non-pressurized private aircraft), altitude of the destination and history of clinical outcome of recent prior air travel may help in making the appropriate recommendations.

Overall, travel on commercial airlines is very safe and most of our patients will be able to travel without special arrangements or delays.

Federal Regulations governing oxygen use in aircraft

It is on the basis of this danger of hypoxia at high altitude that Federal Aviation Regulations Title 14 CFR Section 91.211, Paragraph A require that:

- the minimum flight crew on US civil aircraft be provided with and use supplemental oxygen at cabin pressure altitudes above 12,500 feet mean sea level up to and including 14,000 feet mean sea level for a portion of the flight that is at those altitudes for more than 30 minutes.
- Supplemental oxygen at all times must be provided when aircraft is being operated at altitudes exceeding 14,000 feet mean sea level for flight crew.
- At cabin pressure, altitudes exceeding 15,000 feet, all occupants must be provided with supplemental oxygen.
- Furthermore, 14 CFR Section 91.211B requires that pressurized aircraft have at least a 10 minute additional supply of supplemental oxygen for each occupant when flying at altitudes of flight level 250 in the event of a decompression.
- At flight altitudes above flight level 350, one pilot, at the controls of the aircraft must wear and use an oxygen mask that is secured and sealed. An exception to this regulation exists for two-pilot crew's that operate at or below flight level 410. One pilot does not need to wear and use an oxygen mask if both pilots are at the control and each pilot has a clipped-on oxygen mask that can be placed on the face with one hand from the ready position and properly sealed, secured and is operational within five seconds.

Definition

Hypoxia is defined as the lack of sufficient oxygen supply to the body cells or body tissues caused by an inadequate supply of oxygen, inadequate transportation of oxygen, or inability of the body tissues to utilize the oxygen.

Pathophysiologic types of hypoxia

Hypoxia or lack of oxygen can have a multitude of causes. We distinguish four general groups of hypoxia and will briefly discuss their underlying mechanisms.

Hypoxic hypoxia or altitude hypoxia

is clearly the most hazardous physiological threat to flight crew when flying at altitude. This type of hypoxia is caused by a decreased partial pressure of oxygen in the ambient atmosphere at altitude. Should the crewmember be able to recognize his or her symptoms of hypoxia and take appropriate action, the use of supplemental oxygen will combat hypoxic hypoxia successfully. Note that prolonged breathing of a 100 percent oxygen may cause mild irritation of the airways. However, oxygen toxicity is of no concern when breathing oxygen on board of an aircraft in emergency situations.

An alternative form of decreasing altitude induced hypoxia, in the event of a de-pressurization or failure of an oxygen system, is descent to lower altitudes typically below 10,000 feet.

Stagnant hypoxia:

This type of hypoxia is caused by decreased tissue perfusion or circulation of blood flow to the tissues. In flight, this can occur due to G-forces; and in case of circulatory failure, with the heart being unable to successfully pump blood into the tissues and sustain blood pressure.

Histotoxic hypoxia

describes the inability of the body to use oxygen at the cell and tissue level because of toxins that impair those functions. A classic mechanism for this to occur would be cyanide poisoning but alcohol and other drugs also do have detrimental effects.

Anemic or hypemic hypoxia

this type of hypoxia refers to the decreased ability of the blood to carry oxygen to the body tissues. This can be due to a lack of red blood cells as the carriers of oxygen or contamination of the red blood cells and the hemoglobin with a substance which impairs the ability of the blood to transport oxygen, such as carbon monoxide. This makes an important point pertaining to smoking and flying. Smokers by virtue of having

carbon monoxide in their blood stream from their cigarette smoking are at sea level already at an altitude equivalent of 7000 feet. Thus, smokers are more susceptible to hypoxia at lower altitudes than the non-smoker.

Careful preflight checks of the heating systems and exhaust manifold equipment is mandatory to prevent exhaust gases, including carbon monoxide, from contaminating the breathing atmosphere for the passengers.

Factors influencing acute Hypoxia tolerance

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- Maximum altitude, the rate of ascent to that altitude or the respective rate of de-pressurization.
- The duration of the exposure, which will lead us to the discussion of “time of useful consciousness” and “effective performance time”.
- The level of physical activity or relative rest, because physical activity exacerbates hypoxia.
- Ambient temperature, as cold reduces tolerance.
- The presence or absence of medications and drugs such as alcohol and histamine and nicotine in the blood stream, and also the presence or absence of illness, ie. if someone has decreased pulmonary function or cardiac function he or she may be more susceptible to hypoxia.
- Carbon monoxide exposure, as an example for toxic exposure, will impair a persons ability to tolerate hypoxia.

Duration of Consciousness without Supplemental Oxygen

The effective performance time or time of useful consciousness is defined as:

“ the amount of time in which a person is able to effectively perform flight duties with an insufficient supply of oxygen”.

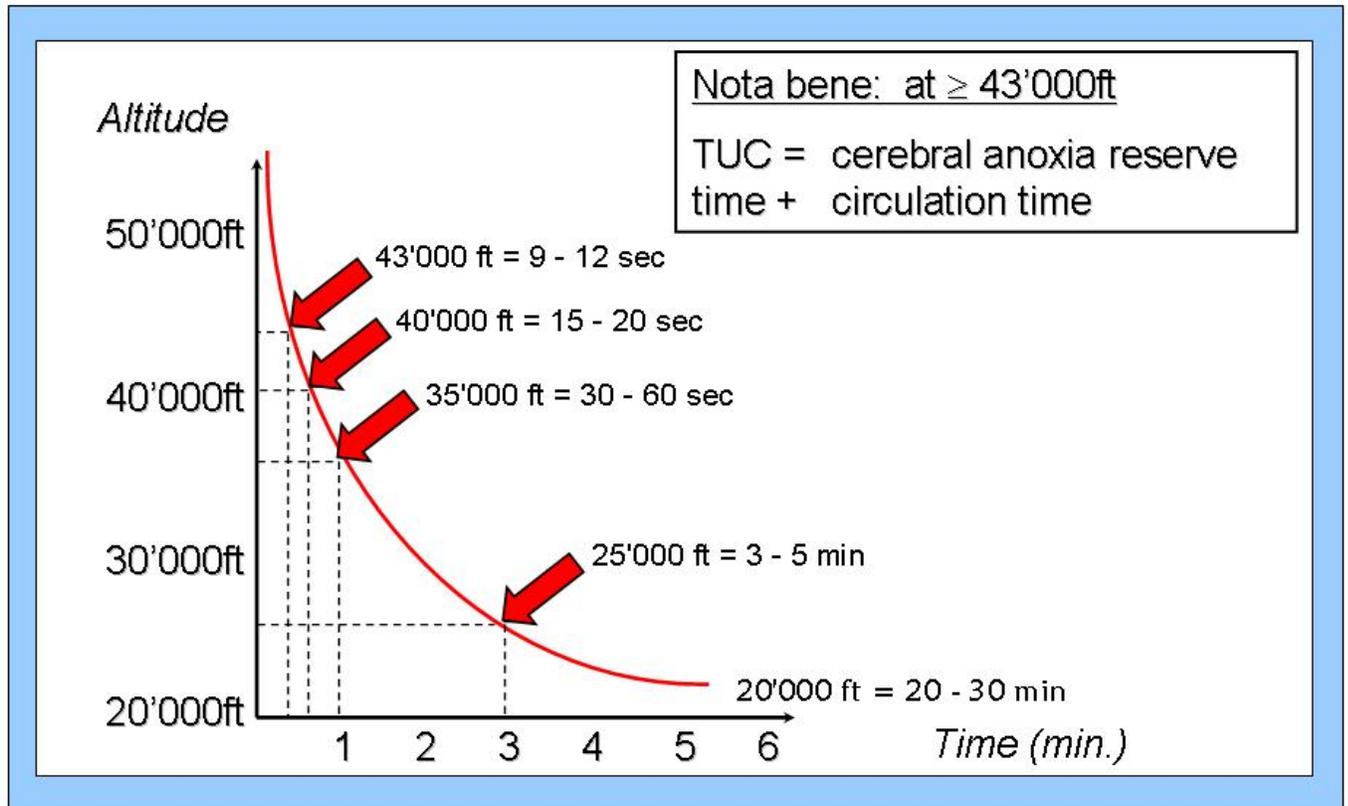
Time of useful consciousness or effective performance time decreases with increasing altitude and eventually coincides with circulation time for blood to go from the lungs to the brain at altitudes in excess of 43,000 feet.

It is useful to remember that:

- at 18,000 feet the effective performance time is about 20-30 minutes;
- at 25,000 feet, it is 3-5 minutes;
- at 35,000 feet, 30-60 seconds; and
- at 43,000 feet, it is less than 10 seconds.

The values that you have been just quoted will be divided in half if experienced after rapid decompression.

Time of useful consciousness (TUC) Effective Performance Time (EPT)



Trapped Gases and Change of Gas Volumes

Definition

These changes are governed by the law of Boyle-Mariotte, which states that with constant temperature the product of a pressure and the volume of a gas stay constant; thus when decreasing, pressure volume will have to increase when we go to altitude, and the inverse will be true when going to depth.

Volume changes

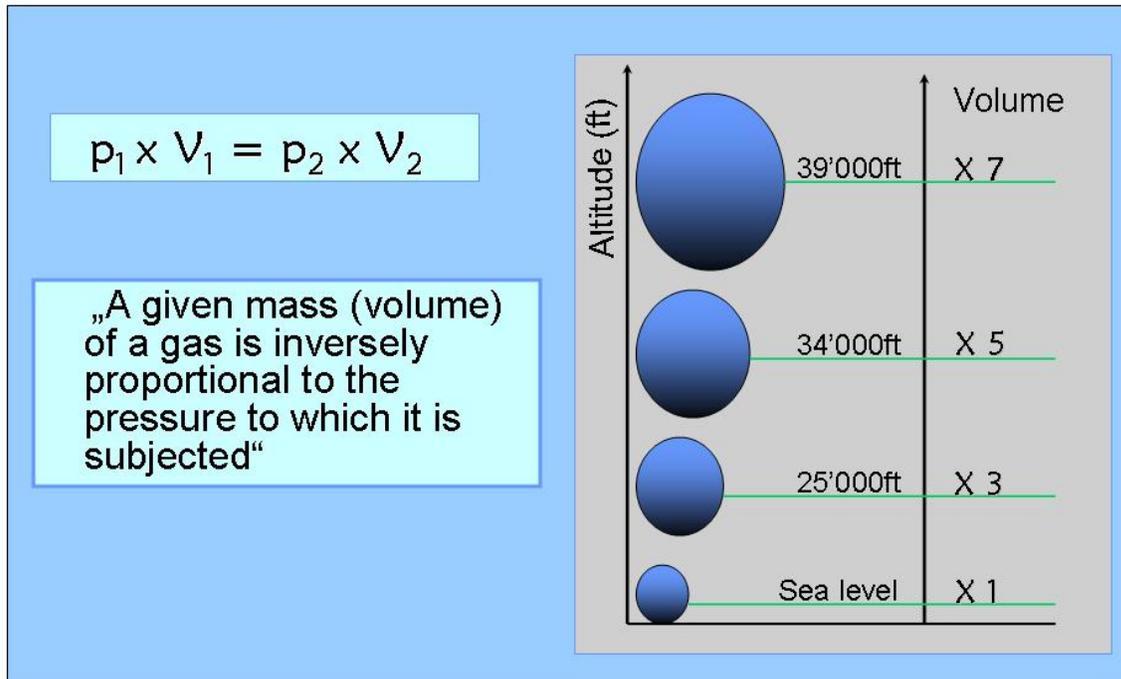
It is important to remember the changes in volume that can be expected when flying to altitude.

At sea level, a volume of one volume unit will:

- double at 18,000 feet
- triple at 25,000 feet, and
- quintuple at 34,000 feet.

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Law of Boyle-Mariotte



This has profound importance and ramification for airspaces that at times(cold, infections) do not communicate freely with the outside world in our body.

We Specifically Refer to the Middle Ear, the Sinuses, and Sometimes Carious Teeth.

What happens, in those airspaces, when we go to altitude is:

- first we experience the expansion of gases,
- we go to altitude which usually will result in pressure equilibrium through the connecting ducts with the outside world; but
- when we then go on to descend, we may experience significant pain and discomfort if there is no ability to equilibrate the pressure within these airspaces and gas becomes trapped.

Middle Ear

In a normal functioning middle ear, there is equal pressure between the eardrum and the external ear (so between middle ear and external ear) because the eustachian tube can allow pressure from mouth and nose to equilibrate with the middle ear.

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Should we have a problem, such as a cold, that would result in the swelling of the eustachian tube, it is not possible for the air to equilibrate between the middle ear and the ambient pressure, which as we descend from altitude will increase, thus creating a relative vacuum in the middle ear creating excruciating, sharp pain.

Sinus

When we go up to 8000 feet, the gas expands in the gas bulb and bubbles come out due to gas expansion. With a sudden descent, liquid is pulled back into the glass bulb due to a relative vacuum that exists. If we think about this very same concept, and now imagine this bulb to be your sinus, then upon descent, we may be experiencing a relative vacuum in that sinus, and thus be liable to significant problems with pain and barotrauma.

Boyle's law & Physiology

Trapping of gas in body cavities

Paranasal Sinuses
(Sinusblock)

Cariou Teeth
(Aerodontalgia)

Middle Ear
(Earblock)

Result: Pain with pressure changes
(esp. descent)

Physical Phenomena of Decompression and its consequences

Flight at high altitude in a pressurized aircraft always carries a small risk of loss of cabin pressurization. Loss of cabin pressurization will result in a sequence of phenomena that are physical in nature and will also have significant physiological consequences.

Decompression rate

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The decompression rate in an aircraft at altitude depends on the size of the breach of the hull of the aircraft; which means, loss of a door will result in a very rapid decompression, a gradual leak will result in a gradual, slow decompression.

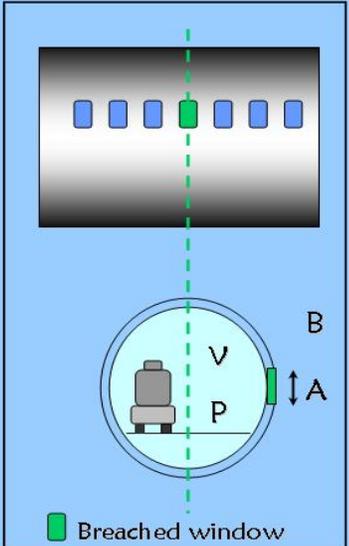
Further determinants of the rate of the decompression are:

- outside ambient barometric pressure
- inside cabin passenger pressure
- volume of the cabin.

Determinants of decompression-rate:
(Fliegner Formula)

$$t \cong 0.22 \frac{V}{A} \sqrt{\frac{P - B}{B}}$$

V: Volume of cabin (cubic feet)
A: cross-sectional area of breach (square inches)
P: initial cabin pressure (psia)
B: actual flight pressure altitude (psi)



For equalization between outside and inside to occur upon loss of cabin integrity, a larger volume aircraft such as a Boeing 747 with a cabin volume of 59,000 cubic feet will take much more time than, for instance, a Lear Jet which has 265 cubic feet.

The ratio in this instance is 223 to 1, which will also translate in equalization of pressure taking thus significantly longer in the larger aircraft.

Any decompression which occurs in less than 0.5 seconds is considered to be explosive in nature and obviously potentially dangerous.

Phenomena of decompression

The phenomena that can be encountered with such a rapid or explosive decompression are:

- a loud sound, alike to an explosion.

- strong wind blast which will carry light material and loose items through the cabin, Medical Implications of Air Travel / Jan Stepanek, MD
- fogging due to rapid cooling of the atmosphere of the aircraft
- rapid onset hypoxia.

It is useful to remember that the time of useful consciousness is cut in half by a rapid decompression also a very rapid cooling of the cabin to the ambient temperature surrounding the aircraft at flight level where the decompression occurs and also there is a distinct possibility for decompression sickness to occur.

Gas Bubble Formation

As we live at the bottom of the atmosphere at sea level, our bodies are saturated with inert gas, mainly nitrogen. If we rapidly decrease the ambient pressure surrounding our bodies –alike to the rapid opening of a carbonated beverage container-, we may experience a set of signs and symptoms that may be due to free gas bubbles starting to develop within our body.

Henry's law

The principle behind these phenomena is based on Henry's Law, which states that

The mass of the gas absorbed by a mass of liquid with which it does not combine chemically, is directly proportional to the partial pressure of the gas above the liquid at a given temperature.

If we now decrease the ambient pressure surrounding our bodies, such as ascending rapidly from great depth when we dive, we can get a condition called the “bends” also known as “caisson disease”.

The same condition is possible when we ascend rapidly to high altitude without breathing oxygen or flying at high altitude, and we experience a rapid decompression resulting in a rapid reduction of pressure surrounding our bodies. The condition in the altitude environment is also known as “aviator bends” or “altitude decompression sickness”.

The emergency procedure for both is the same; oxygen masks should be donned immediately and a rapid descent initiated as soon as possible to avoid the symptoms and signs of hypoxia.

In this context, it also is important to mention that flying after diving, due to the before discussed increase in inert gases being dissolved in our bodies, tends to carry more risk. Thus, the recommended waiting period before going to flight altitudes of 8000 feet is at least 12-hours after non-decompression stop diving and 24-hours after decompression stop diving.

If flying in a non-pressurized aircraft above 8000 feet, the recommended waiting time is at least 24-hours after any scuba diving.

Manifestation of the Bends

Let us briefly touch upon the signs and symptoms of the bends. The evolved gas in decompression sickness typically manifests with pain in and around joints, this can become quite incapacitating if severe, other organ systems can also be affected. More serious is the affliction of heart and lungs, which is referred to as the “chokes”(chest pain and burning sensation underneath the chest, a desire to cough, and -if no action such as oxygen breathing and immediate descent is taken- collapse and unconsciousness).

Neurological signs of decompression sickness may involve a sense of tingling, itching, or rash on the body, problems with vision, such as lines or spots, blurred vision, temporary paralysis, slurred speech, and seizures.

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Should, in the context of a rapid decompression at altitude, any such symptoms occur, then treatment with oxygen and medical attention for possible treatment in a recompression chamber should be considered.

Cabin Environment in High Altitude Operations

Radiation Exposure

Cosmic radiation is one of the key sources of radiation exposure in high altitude flight. Typically this radiation is the result of collisions of photons and helium particles with the atmosphere where they produce secondary radiation derived from the collision events described. This type of radiation is responsible for 17 % of all natural background radiation that we experience at ground level.

An additional source of radiation are solar flares, which result in the release of charged particles from the sun, which then collide with the atmosphere (solar storm). The earth is shielded by its atmosphere and its magnetic field.

The higher the flight altitude, the lesser is the protective shielding that can be provided by earth's atmosphere. The earth's magnetic field provides more shielding capacity at the equator as opposed to the poles.

The effect of solar activity on radiation dose received by the earth is much less significant than the effect of latitude.

The ICRP (International Commission on Radiological Protection, 1991) recommended exposure limits of 20mSv/year (averaged over 5years) for crewmembers (= maximum mean body effective dose). While recommendations for passengers call for limits of 1 mSv/ year and ≤ 1 mSv during pregnancy.

The European Union Council recommended exposure limits at 6mSv/year. Workers, who get > 1 mSv/year should be advised of scheduling opportunities that could decrease exposure, most important is the attention to a pregnant aircrew member in this regard.

Average yearly exposure in short haul flight operations is about 1-2 mSv/ year and in long haul flight operations at 4-5 mSv/year.

This should be viewed in perspective as one trip from Los Angeles to New York is about equivalent to 0.03 mSv and one chest X-ray is 0.2 mSv. One full body CT scan equals 12mSv and living in Denver, Colorado results in an exposure of about 6mSv/y.

Ozone

Ozone is a gas that forms at an altitude of 40,000 ft to 100,000 ft based on the reaction of UV-radiation with the atmosphere. The resultant gas is present in concentrations of 1 ppmv at 40,000 ft and 10 ppmv at 100,000ft. The cabin limit is at ≤ 0.25 ppmv. The catalytic converters in aircraft easily break down ozone at temperatures of > 400 degrees Celsius. At 1 ppmv airway irritation occurs and at 10 ppmv frank pulmonary edema ensues.

Cabin Air Quality

Numerous factors contribute to good cabin air quality and are listed below:

- a. pressurization
- b. oxygen content
- c. carbon dioxide content
- d. temperature
- e. ozone content
- f. humidity
- g. bioaerosols
- h. tobacco smoke

The single most important factor in significantly improving cabin air quality has been the introduction of smoking bans on board of aircraft.

The cabin air at altitude tends to be very dry due to the low moisture content of the ambient air at that altitude, usual numbers that are seen in a cabin at altitude are 6-10 % main cabin and 3% flight deck. The dryness of the air may lead to a sense of dry eyes and mucous membrane irritation.

The air in aircraft is completely exchanged every 3-4minutes as opposed to every 12 minutes in a residential home. Up to 30-50% of the air is recirculated to improve relative humidity of the air. All air is filtered via HEPA filters that capture particles the size of 0.3 micrometers.

Carbondioxide levels in the cabin are usually maintained at levels of 0.5% (equivalent to sea level).
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Systematic approach to some medical conditions:

Cardiovascular conditions

Exposure to altitude results in mild hypoxia, which in turn leads to increased heart rate (5-10% at 2000-2500m) and, thus, increased myocardial oxygen demand.³ The body responds by increasing respiratory rate and tidal volume, thereby increasing oxygen supply to meet demand and compensate.

Fit to fly:

- stable CHF, stable CAD
- post MI:
 - 3 weeks (uncomplicated)
 - 6 weeks (complicated)
 - if patient is asymptomatic and has good functional capacity on exercise treadmill testing
 - consider in-flight oxygen (2 -4 L/min by NC)
- post CABG:
 - wait 14days (absorption of intra-thoracic gas)
- post PTCA:
 - may travel within days if no complications
 - if clinical status pre-PTCA is tenuous, advisable to wait 1-2 weeks
- post pacemaker (PM) / AICD (automatic implanted cardioverter - defibrillator) - insertion:
 - may travel once medically stable

CV contraindications to commercial airline flight:

- MI (uncomplicated < 3 weeks ago, complicated < 6 weeks ago)
- CVA within 2 weeks
- Severe, symptomatic valvular disease
- Eisenmenger syndrome
- Uncontrolled, symptomatic hypertension, ventricular or supra-ventricular arrhythmias
- Unstable angina

Cardiovascular indications for medical oxygen in flight:

- Use of oxygen at baseline
- Baseline PaO₂ < 70 mmHg or CHF NYHA class III or IV
- Angina CCS class III or IV
- Cyanotic congenital heart disease
- Primary pulmonary hypertension

- Other cardiovascular diseases with known sea level hypoxemia
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General recommendations:

1. Advise patient to use curbside check-in, wheelchairs, electrical trolley cars for transport within airports, as well as pre-boarding when available
2. Carry all medications on board in carry-on luggage
3. Include most recent ECG (high resolution) printout, and consider carrying a printed medical summary in carry-on luggage
4. Consider in-flight oxygen as needed
5. Notify airline 48 to 72 hours prior to flight regarding special needs

Pulmonary conditions

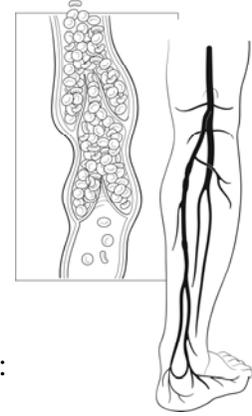
The single most helpful test is a functional assessment and the measurement of arterial blood gases. PaO_2 at ground level is the best predictor of altitude PaO_2 . A $\text{PaO}_2 > 70$ mmHg is in most cases adequate for travel without in-flight medical oxygen. A very low PaO_2 may require ground transportation and render air travel unsafe for the individual. Hypercapnia on ABG is a sign of poor pulmonary reserve and increased risk at altitude. Patients with severe, poorly controlled asthma should consider ground transportation. Patients with mild or well controlled asthma should always carry their medications on board.

A pneumothorax is an absolute contraindication to air travel, due to the potential expansion during flight and possibility of a tension-pneumothorax.

- Order end expiratory chest radiograph to confirm diagnosis
- May travel 2 - 3 weeks after successful drainage
- Stable patients with a persistent bronchopleural fistula may travel safely with a one-way Heimlich valve assembly
- Large pleural effusion:
 - drainage 14 days prior to flight
 - post-thoracentesis radiograph indicated prior to flight

Deep venous thrombosis (DVT)

Travel aboard commercial aircraft - like any other forms of travel with prolonged immobility - may predispose passengers to "traveler's thrombosis."



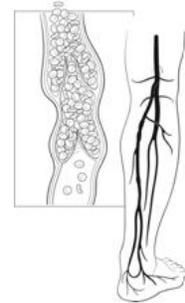
The following measures may assist in the prevention of the development of DVT:

- Exercise by walking in the aisle every hour
- Avoid placing baggage under the seat in front of you to preserve space for stretching your legs
- Avoid prolonged sitting with crossed legs
- Periodically dorsiflex and plantar extend feet
- Maintain adequate hydration, avoid alcohol and caffeine
- In patients with pre-existing risk factors for DVT:
 - Elastic compression stockings (20 – 30 mmHg compression strength)
 - Subcutaneous heparin pre- and post-flight
 - Full oral anticoagulation

Risk stratification

High Risk:

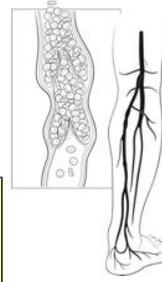
- Travel: > 5000 km or > 8h
- Thrombophilia, recent major surgery (<6 w), malignancy, CHF (EF < 20%)



Recommendations:

- Below knee compression stockings at 20-30mmHg, mobilization, hydration, aisle seat
- LMWH 1 injection 2-4 h prior to departure / Warfarin Rx.

Possick SE. Ann Intern Med. 2004;141:148-154.



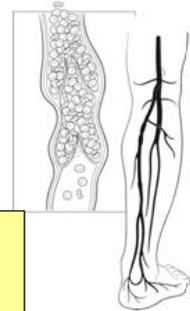
Moderate Risk:

- Travel: > 5000 km or > 8h
- > 50y or < 50 y with: CVI, CHF (EF 20 – 40%), HRT or OCP, Pregnancy, Obesity

– Recommendations:

- Below knee compression stockings at 20-30mmHg, mobilization, hydration, aisle seat
- Aspirin: no trials (NNT to prevent 1 DVT: 17,000)

Locke. Medscape Medicine Review.2006.



Low Risk:

- Travel: < 5000 km or < 8h
- Elevated BMI, > 40 y, recent minor surgery

– Recommendations:

- Mobilization, hydration, possibly below knee compression stockings (esp. if edema is issue)

- Seizures:
 - Sleep deprivation, alcohol, dehydration, hypoxia, fatigue and jet lag all can lower seizure threshold
 - frequent, uncontrolled seizures : no air travel recommended,
 - well controlled seizures : take medications along (all in carry-on luggage), consider companion for travel, consider breaking long trips up into smaller legs and get sleep during the stopover
- Recreational diving:
 - < 2 hours cumulative dive time in the 48 hours prior to flight : wait 12 hours
 - multi-day, unlimited diving : wait 24 hours
 - dives requiring decompression stops : wait 24 to 48 hours
- Decompression sickness:
 - no air travel until fully treated and released for travel by hyperbaric medicine specialist
- Diabetes mellitus:
 - no restrictions for air travel, always advise patients to carry their medicines (including oral hypoglycemics and insulin), syringes and glucometer in the carry-on luggage and *never* exclusively in the checked luggage

Pregnancy & Infants

Fetal hemoglobin oxygen saturations are near normal while at an altitude of 2438 m. Most airlines allow air travel without any medical certificates up to the 36th week of pregnancy. Should travel be critical after the 36th week, then a letter from the obstetrician needs to accompany the woman documenting the status of the cervix and the fact that the patient is not in labor.

Women with significant *morning sickness* may benefit from being seated near the wings (less turbulence) and from avoidance of gas-producing foods. In the later stages of pregnancy, it is important to avoid injury of the pregnant woman while ambulating in the aisle and to ensure that the seat belt is worn over the pelvis and under the pregnant abdomen.

Contraindications to air travel for pregnant passengers include:

- Current bleeding, pain
- History of premature deliveries
- Cervical incompetence
- > 36th week of gestation

The healthy newborn may safely fly 1 week postpartum. Use of a pacifier or feeding the baby on descent of the aircraft will prevent painful ear block.

Conditions affecting ear, nose and throat

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The middle ear and the different sinuses constitute potential areas for trapped gas to develop. Their connections to the ambient air are small and can easily become obstructed by edema due to infection, allergy or polyps.

The resulting clinical symptoms typically develop upon descent. The increase in ambient pressure results in a relative vacuum in an affected sinus resulting in severe, stabbing pain, submucosal hemorrhage and - in the case of the middle ear - even rupture of the tympanic membrane.

- In the case of an upper respiratory infection or severe allergies, elective air travel should be delayed
- If travel is crucial, then a clinically appropriate combination of antibiotic and decongestant therapy is indicated
- Avoid sleeping during descent of the aircraft
- A maneuver repeated every 30 sec during descent helps in equalizing pressure and avoiding clinical signs and symptoms

Maneuvers designed to allow for pressure equilibration between middle ear and oropharynx:

- swallowing with closed mouth and closed nostrils (Toynbee maneuver)
- moving jaw, chewing gum
- Beance Tubulaire Volontaire
- Valsalva maneuver

Air travel after surgery

Air travel should be avoided after surgery of the abdomen, chest and hollow viscus for at least 1 to 2 weeks to allow for postoperative absorption of gas. After colonoscopy with polypectomy, a 24 hour waiting period prior to air travel is prudent to allow for absorption of intra-colonic gas. The risk of gas expansion should be considered in patients with a history of recent intra-cranial surgery.

In-flight assistance to the passenger

Medical oxygen

Airlines may provide medical oxygen to patients in flight. The airline should be contacted 48 to 72 hours prior to the flight and a medical statement regarding the necessary flow rate provided to enable the airline

to determine the volume of oxygen needed for the patient. The airline provides continuous flow oxygen with a face mask or nasal cannula with flow rates of up to 4 liters/min. The airlines do not provide oxygen for the patient prior to enplanement and after leaving the aircraft at an airport. Separate arrangements with local oxygen providers must be made accordingly. The use of oxygen in flight is covered under Medicare Part B for Medicare beneficiaries with a certificate of medical necessity.

The FAA recently (August 11th 2005) authorized the use of medical oxygen concentrators (AirSep, Inogen) in flight for patients requiring in flight oxygen use, thus greatly facilitating the use of in flight oxygen and use of oxygen at airports. The patient will require a physician note stating that there is a medical need for oxygen.

Emergency in-flight assistance to a passenger

Airlines with their own medical department frequently take emergency calls of their aircraft or have a designated emergency call routing system. Mayo Clinic serves as an emergency in-flight assistance call center for Northwest Airlines via the emergency communications center at St. Marys Hospital. Calls are answered by Mayo flight nurses, who are part of the Mayo One team, with back-up from emergency room staff physicians as needed.

When a physician is called upon to assist a passenger in need of medical attention in flight, he is covered by the "Good Samaritan Law" passed in 1998 in the Aviation Medical Assistance Act: *"An individual shall not be liable for damages in any action brought in a Federal or State court arising out of the acts or omissions of the individual in attempting to provide assistance in the case of an in-flight emergency, unless the individual, while rendering such assistance, is guilty of gross negligence or willful misconduct"*.

The physician can expect to encounter an airline medical kit (FAA-mandated) containing at least the following supplies: iv Diphenhydramine, Nitroglycerine tablets, 50% Glucose solution, Epinephrine 1:1000, non-narcotic analgesic, antihistamine tablets, Atropine, Aspirin, inhaled bronchodilators, Lidocaine, Epinephrine 1:10,000. By July of 2004, all aircraft with at least one flight attendant and a payload of > 7500 pounds will be required to have an onboard automatic external defibrillator (AED). These devices will be useful in identifying cardiac rhythms and may decrease mortality from electrically treatable, potentially lethal rhythms.

Future developments

Commercial air travel will continue to grow and will represent an increasingly important mode of transportation. Western Occupational Health and Safety Conference, AZ 10 September 10-12, 2009

US air traffic continues to expand to accommodate the needs of the traveling public.
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