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Behaviour of Cardiac Patient's during Landing from Aircraft at Airport.

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Abstract

Patients with heart failure are at a higher risk of cardiovascular events compared with the general population, particularly during domestic or international travel. Patients with heart failure should adhere to specific recommendations during travel to lower their risk of developing heart failuresymptoms. In this Review, we aim to provide clinicians with a set of guidelines for patients with heart failure embarking on national or international travel. Considerations when choosing a travel destination include travel distance and time, the season upon arrival, air pollution levels, jet lag and altitude level because all these factors can increase the risk of symptom development in patients with heart failure. In particular, volume depletion is of major concern while travelling given that it can contribute to worsening heart failure symptoms. Pre-travel risk assessment should be performed by a clinician 4–6 weeks before departure, and patients should receive advice on potential travel-related illness and on strategies to prevent volume depletion. Oxygen supplementation might be useful forpatients who are very symptomatic. Upon arrival at the destination, potential drug-induced photosensitivity (particularly in tropical destinations) and risks associated with the local cuisine require consideration. Special recommendations are needed for patients with cardiac implantable electronic devices or left ventricular assist devices as well as for those who have undergone major cardiac surgery.

Introduction

Domestic and international travel are associated with increased health risks, with 20– 70% of individuals reporting health issues during their travels. During international travel, 1–5% of individuals seek medical attention and the rate of death among travellersis 1 in 100,000, with cardiovascular disease being the most frequent cause of death. Trauma, particularly from motor vehicle accidents, is another

major cause of death while travelling[1]. Health-care providers are frequently approached by patients for advice on how to prepare for travel or to determine whether travelling is advisable at all. General practitioners can provide information to healthy individuals but specialist consultation is of benefit for patients with underlying illnesses such heart failure (HF). Indeed, many patients with HF intend to travel for business or leisure. Although some guidance has been published[3], a systematic overview of recommendations for patients with HF planning to travel is not yet available. In this Review, we aim to provide clinicians with recommendations for preparatory measures before travel to inform and educate patients with HF. We discussfactors that might increase the risk of HF symptom development, such as local climate, air pollution levels and altitude levels, and provide specific guidance for patients with a cardiac implantable device and those who have undergone major surgery.

Which patients with HF can travel safely?

To date, guidance on travel recommendations for patients with HF is limited. In general, patients with NYHA class I–III HF who are stable should be able to travel safely. However, patients with NYHA class III HF who are planning to travel by air should be advised to consideron-board medical oxygen support. Patients with NYHA class IV should not travel; however, if travel is unavoidable, on-board oxygen and medical assistance should be requested. A patient with an oxygen saturation rate >90% at ground level usually will not require medical oxygen during flight. An overview of whether travel-ling is advisable for different classes of HF isprovided conversely; those residing in a cold climate are most sensitive to heat. Exposure to extreme heat has been associated with increased morbidity and mortality from heat exhaustion and heat stroke. Maintenance of homeostasis during hot weather requires an increase in cardiac output; heat tolerance is impaired when cardiac output cannot be increased to meet the requirements of heat loss. Numerous medications that are frequently prescribed for individuals with HF can also increase susceptibility to heat stroke, including loop diuretics, sero-tonic antidepressants, angiotensin-converting enzyme inhibitors and proton- pump inhibitors. Colder temperatures are less likely to have effects on cardiovascular health but have been associated with increased morbidity among patients with respiratory disease. Patients with HF should be advised to choose either spring or autumn for international travel to avoid travelling during extremities in weather and to adjust medications that can contribute to volume depletion. Appropriate clothing is required for the site of departure, the destination and for the journey itself. Given the challenges in contacting a patient's primary care physician if the patient is in a different country or continent, distant travel destinations

might only be advisable for patients who are well-informed about their medication regimen, dietary restrictions and exercise limitations.

Endemic diseases

The need for immunization for travel depends on the destination. In general, the status of routine vaccinations, such as the diphtheria, measles–mumps–rubella, pertussis, tetanus and varicella vaccines, should be checked before travelling abroad. For all patients with HF, vaccines are required for pneumococcal disease, influenza and corona virus disease2019 (COVID-19).

Altitude induced hypoxia and HF

Patients with HF are more susceptible to the physiological changes induced by high altitude exposure than the general population. During air travel, cabin pressure is required to be no less than the barometric pressure at an altitude of 2,438 m (8,000 ft), which is classified as an intermediate altitude. Cabin pressures usually remain higher than this altitude, particularly during long-haul flights. Travel to high altitude locations that are >2,500 m above sea level triggers physiological acclimatization processes within the cardio circulatory and pulmonary systems. These processes are initiated by a gradual decrease in barometric pressure, which in turn lowers the partial pressure of oxygen in inspired air. Hypobaric hypoxia leads to a fast increase in respiratory rate and tidal volume which leads to respiratory alkalosis and hypoxic diuresis Hypoxia, induces pulmonary vasoconstriction and eventual pulmonary hypertension, an important trigger for high altitude pulmonary oedema. To compensate for the lower arterial oxygen content, heart rate and stroke volume.

Seasonal variations and HF

Hospitalizations owing to worsening HF show intriguing seasonality, with a substantial decline during warmer periods and an increase during colder periods especially in older patients Temperature had the greatest (inverse) correlation with hospitalizations for HF among other causative environmental factors such as humidity, precipitation or irradiation. Skin cooling has been shown to increase vascular resistance and plasma noradrenaline concentration, which might lead to HF decompensation. Beyond neurohumoural activation and hemodynamic stress, respiratory infections, which peak during the colder months, can precipitate and aggravate HF symptoms. Furthermore, vitamin D insufficiency during winter has also been linked to worsening HF. Interestingly, the effect of seasonal variability on health is more prominent in elderly people and winter hospitalization is associated with both poorer short-term and long-term prognosis. These

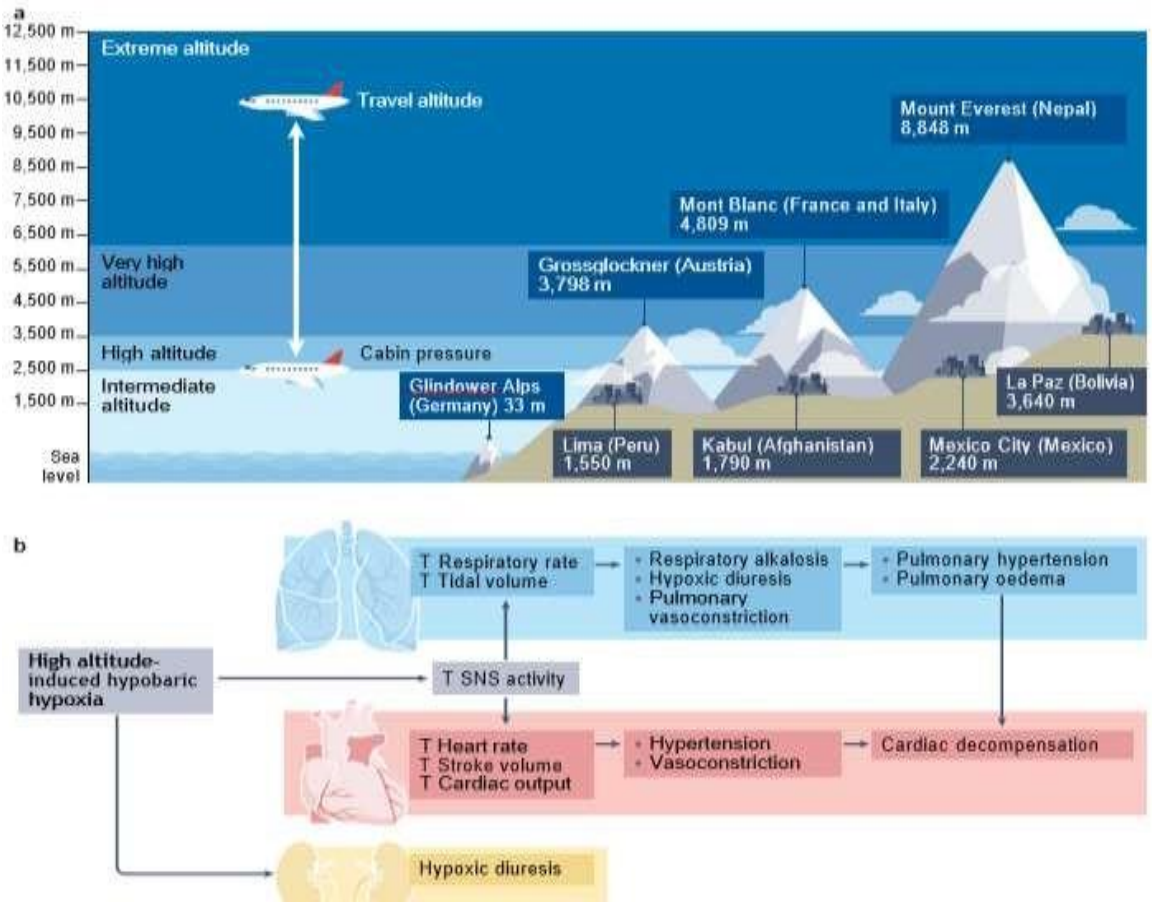
observations suggest that patients with more severe HF (and worse prognosis) are prone to decompensation during winter and that these patients and older patients with more advanced disease should be advised to avoid travelling to colder regions. Of note, a study fromNorway reported that the Christmas winter period was associated with the high- est rates of excess all-cause and cardiovascular deaths[45]. Overall, appropriate clothing and heating strategies need to be carefully selected for optimal stabilization of body core temperatures, vitamin D levels should be measured before departure and supplemented if required, and vac cines against influenza and pneumococcal disease should be administered.

Preparing to travel

Any patient with a history of HF should seek medical consultation before departure, particularly when travel- ling overseas or when leaving for a long period. Women are generally more likely to seek pre-travel medical advice than men and are also more likely to have travel- related worries. A cross-sectional national survey found that a low perceived need was among the main causes for avoiding medical care, often because patients expected their illness or symptoms to improve over time. For patients with HF, travel preparation should include a specialist consultation approximately 4–6 weeks before departure. This consultation should follow a structured and sequenced approach, which should involve risk assessment (including an evaluation of medical history and travel itinerary), interventions required.

Special considerations

Patients who have undergone recent surgery. Major cardiac surgery ranges from minimally invasive approaches to complete sternotomy. The Canadian Cardiac Society guidelines on air travel recommend that patients with a hemoglobin level <9 g/dl who have undergone coronary.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Sea level
Extreme altitude
Travel altitude
Very high altitude
High altitude
Intermediate altitude
Cabin pressure
Mount Everest (Nepal) 8,848 m
Mont Blanc (France and Italy) 4,809 m
Grossglockner (Austria) 3,798 m
Glindower Alps (Germany) 33 m
La Paz (Bolivia) 3,640 m
Lima (Peru) 1,550 m
Kabul (Afghanistan) 1,790 m
Mexico City (Mexico) 2,240 m
b
↑ Respiratory rate
↑ Tidal volume
• Respiratory alkalosis
• Hypoxic diuresis
• Pulmonary vasoconstriction
• Pulmonary hypertension
• Pulmonary oedema
High altitude-induced hypobaric hypoxia
↑ SNS activity
↑ Heart rate
↑ Stroke volume
↑ Cardiac output
• Hypertension
• Vasoconstriction
Cardiac decompensation
Hypoxic diuresis

Venous thromboembolism

The risk of deep venous thrombosis (DVT) is greatly increased in patients with incident HF according to data from the ARIC cohort and a systematic review. The term 'economy class syndrome' has been used to describe the venous complications caused by cramped seating conditions. The risk of DVT or pulmonary embolism is increased during travel that is >4 hours in duration, most probably owing to the associated immobility that isa key component of the Virchow triad of hyper coagulability, stasis and endothelial injury. Travelling in general (>4 hours in the preceding 8 weeks) is associated with a two fold increase in the risk of venous thrombosis. This risk seems to be similar regardless of the mode of transportation (airplane, bus or train). The overall absolute incidence of symptomatic venous thromboembolism

(VTE) in healthy individuals within the first month after a flight lasting >4 hours is approximately 1 in 4,600 flights and increases by 18% for each additional 2 hours in flight duration. Importantly, the risk of VTE in individuals with pro-thrombotic risk factors, such as chronic HF, is substantially higher than in the general population.

Medical emergencies during air travel

Patients with HF can travel by air if their condition is stable Commercial airplanes are required to carry basic emergency medical equipment according to regulations of the Federal Aviation Administration (FAA) in the USA and the European Aviation Safety Agency (EASA) in Europe. Commercial aircrafts travelling from Europe to the USA have to meet both FAA and EASA requirements and, thus, must carry on board an external automated defibrillator, a saline infusion system and a bag-valve mask resuscitator.

Data on on-board medical emergencies are sparse owing to the lack of international registries. According to the available data provided by the airline Lufthansa, which contains details on approximately 20,000 on-board medical events from 2000 to 2011, cardiac emergencies accounted for 43% of on-board incidents. Reported medical issues included circulatory collapse, high blood pressure, chest symptoms and dehydration. On-board treatment included blood pressure management in 76% of incidents, drug administration in 54%, oxygen delivery in 48%, blood glucose measurement in 9%, monitoring of oxygen saturation in 6% and use of an automated external defibrillator in 6%.

Dietary considerations

Dietary intake of fluids, sodium, potassium and alcohol during travel should be guided by current ESC recommendations for the management of patients with HF. According to the guidelines, fluid restriction of

Medical emergencies during air travel patients with HF can travel byair if their condition is stable.

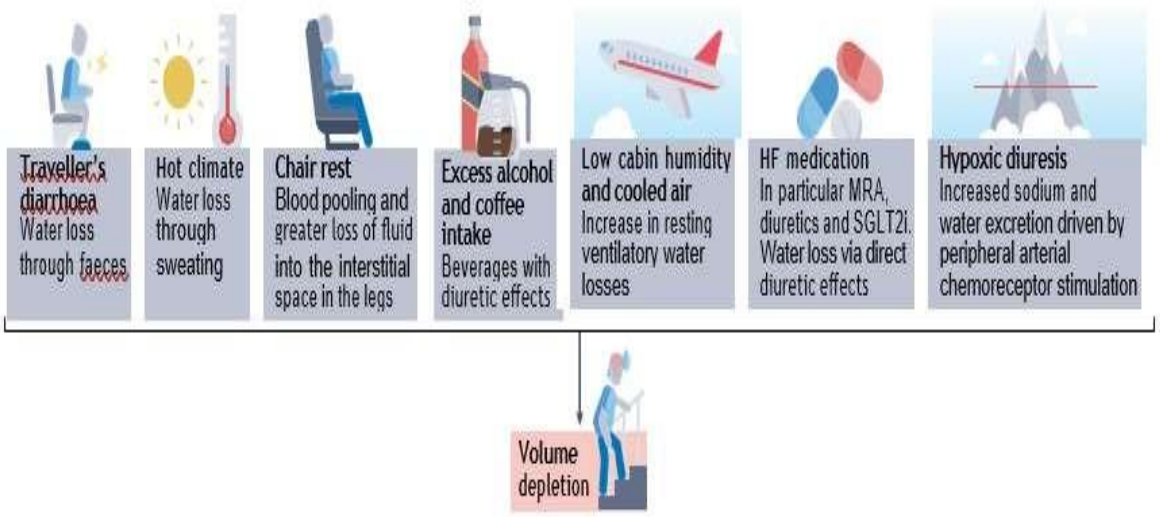

Fig. 2 | **Contributors to volume depletion during travel in patients with HF.** A vast array of factors contributes to volume depletion in patients with heart failure (HF) and require medication adjustment and increased fluid intake. MRA, mineralocorticoid receptor antagonists; SGLT2i, sodium–glucose cotransporter 2 inhibitor.

Air travel Metal detectors at airport security check points do not interfere with CIEDs. However, patients with ICDs should be advised to have their device card ready to show to airport personnel before walking through the security checkpoint. To minimize the risk of interference, patients should move through metal detector gates at normal walking speed and should not linger. Hand- held scanners should not affect CIED functionality but patients should ask personnel to move the wand over the device quickly and only once.

Magnets are not allowed in carry-on luggage and thus cannot be used to remedy inappropriate device activity on airplanes. EMI inside airplanes is rare but has been reported, for example, in association with electronic chair handles. Finally, cosmic radiation is approximately 100-fold higher during air travel, which increases therisk of radiation-induced EMI (for example, power-on.)

Conclusions

The list of considerations for patients with HF embarking on national or international travel is extensive. Patients should be aware of an increased risk of cardio-vascular events during their travels, which can be reduced with meticulous pre-travel risk assessment, physical examination, therapy adjustment and education. Pre-travel risk assessment should involve research into the local climate, air pollution levels, the distance and time fortravelling, potential jet lag and altitude. En route, patients with HF should avoid volume depletion caused by extended chair rest, low cabin humidity and cooled air, excess alcoholor coffee intake, drugs with diuretic effects, hypoxia or traveler's diarrhea. Upon arrival atthe

destination, drug-induced photosensitivity and the health effects of local foods and beverages require consideration. Special recommendations are needed for patients after implantation of cardiac rhythm devices or LVADs as well as for patients who have undergone major cardiac surgery.

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