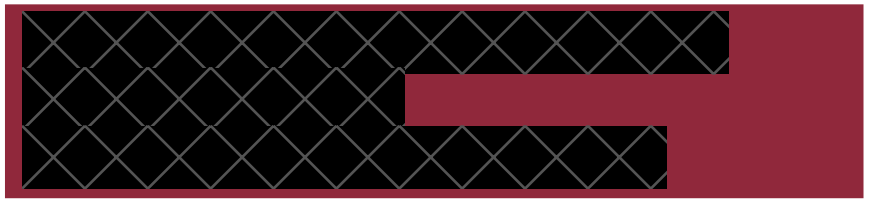
# In flight critical care during strategical aeromedical evacuation of SOF casualties

*SOF Combat Medical Care Conference – Paris – October 20th, 2022*



# Conflicts of interest

The assertions are the personal point of view of the author and do not represent the message of the french medical health service or french armed forces.

# What are we talking about?

- SOF casualties
  - Severely injured patients
  - Low number (usually 1 to 3)

- Operations
  - Low footprint on the ground
  - No role 3

Precoce StratMEDEVAC

# French survival chain

# Definition – A combat operation

**MEDEVAC = Medical evacuation**

**AERO-MEDEVAC**

**STRAT-MEDEVAC : from the theater to the homeland**

These operations are decisive for the engagement of the armed forces.

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# An healthcare operation

**The aim is to provide en-route care with a continuum of quality of care**

**and security for the patients.**

Avoid monitoring rupture and load breaks, despite a challenging environment and

despite isolation during several hours

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# MEDEVAC triple interest

- Medical
  - Transport the patients to the best medical and surgical environment
- Psychological
  - Soldiers keep in mind that they rapidly will benefit from the best level of care
- Operational
  - Avoid the saturation of the medical facilities and allow the ongoing of combat operations

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# French activity

- Each year : around 800 patients
- Each year : around 50 intensive care patients

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# Typology of patients

- 2015 – 2017 : 2129 French patients

- Medicine or non-traumatic surgery : 48 %

- Trauma : 48 %
  - Non battle injury = 43%
  - Battle injury = 3%

- Psychiatry 5%



Luft A. et al. Military Medicine 2019

# Intensive care patient and MEDEVAC

16 years period

| | Trauma patients ($n = 245$) | Medical patients ($n = 207$) | p |
|---|---|---|---|
| Age* | 28 [24–33] | 35 [28–45] | < 0,001 |
| SAPS-II* | 13 [8–40] | 11 [8–16] | 0,027 |
| Initial GCS < 8** | 33 (13%) | 19 (9%) | 0,202 |
| Vasopressor support** | 74 (30%) | 29 (14%) | < 0,001 |
| Mechanical ventilation** | 119 (49%) | 36 (17%) | < 0,001 |
| Emergency surgery** | 174 (71%) | 14 (7%) | < 0,001 |

SAPS-II: Simplified Acute Physiology Score-II.

GCS: Glasgow Coma Scale.

* median [1st-3rd quartile range].

** number (%).

Ponsin P et al. Injury 2020

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# Intensive care patient and MEDEVAC

The most severe patients are those suspectible of in-flight worsening events

Factors associated with in-flight worsening health status.

| | In-flight worsening health status ($n$ = 123) | Absence of in-flight worsening health status ($n$ = 329) | p |
|---|---|---|---|
| **Age*** | 31,5 [25,0 ;36,0] | 32,7 [25,0 ;38,0] | 0,198 |
| **SAPS-II*** | 23,18 [8,0 ;40,0] | 16,2 [8,0 ;18,0] | <0,001 |
| **Trauma**** | 71 (58%) | 174 (53%) | 0,42 |
| **Cardiovascular disease**** | 13 (10%) | 56 (17%) | 0,121 |
| **Initial GCS < 8**** | 17 (10%) | 35 (2%) | 0,606 |
| **Vasopressor support**** | 48 (39%) | 55 (17%) | < 0,001 |
| **Mechanical ventilation**** | 64 (52%) | 91 (28%) | < 0,001 |
| **Emergency surgery**** | 65 (52%) | 123 (38%) | 0,004 |
| **Hemorrhagic shock**** | 22 (18%) | 24 (7%) | 0,004 |

* median [1st-3rd quartile range].
** number (%).

Ponsin P et al. Injury 2020

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# What is necessary?

- A same langage
- Classification of patients
- Medical informations
- Logisitical organization
- Command and control medical and aeronautic

- Aircraft
- Medical teams
- Material and medical devices

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# STRAT MEDEVAC classification

PMR
STANAG 3204

- **PRIORITY**
  - P1 : Urgent < 12h
  - P2 : Priority < 24 H
  - P3 : Routine < 72 H

Notice to move
=
Delay from the order
to the take-Off

- **DEPENDENCY**
  - D1 : High : MV (require intensive support)
  - D2 : Medium : IV lines, $O_2$, drainages, deterioration possible
  - D3 : Low : no deterioration expected
  - D4 : Minimal : help for moving

# Command and control


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# MEDEVAC teams

- **Crews of the French armed forces**
- **Medical doctors and nurses**
- **Anesthesiologist**

**On duty 24h 7/7**

Aeronautic, Medical Competences and non technical skills

Teamworking

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# Material

- Preconditionned material
- Boxes loaded and easy to plug on board in a few minutes (<1 hour)

- MEDEVAC : a way for reconditionning the medical operational units (blood)




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# Medical devices


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# Aircrafts


Confortable
High distance
Rapid flight

High quality of airport runway

Air superiority is required

# Individual or bi-individiual MEDEVAC

Elongation : 7400 km

Delay Alert – Take off = hours

50 flights each year

# On key-word

ANTICIPATION

Need to anticipate the problem related to the pathology

(refer to PMR and **to DoC to Doc call before the mission**)

Need to know your material and devices

Need to know the specific constraints

due to the aircraft environment

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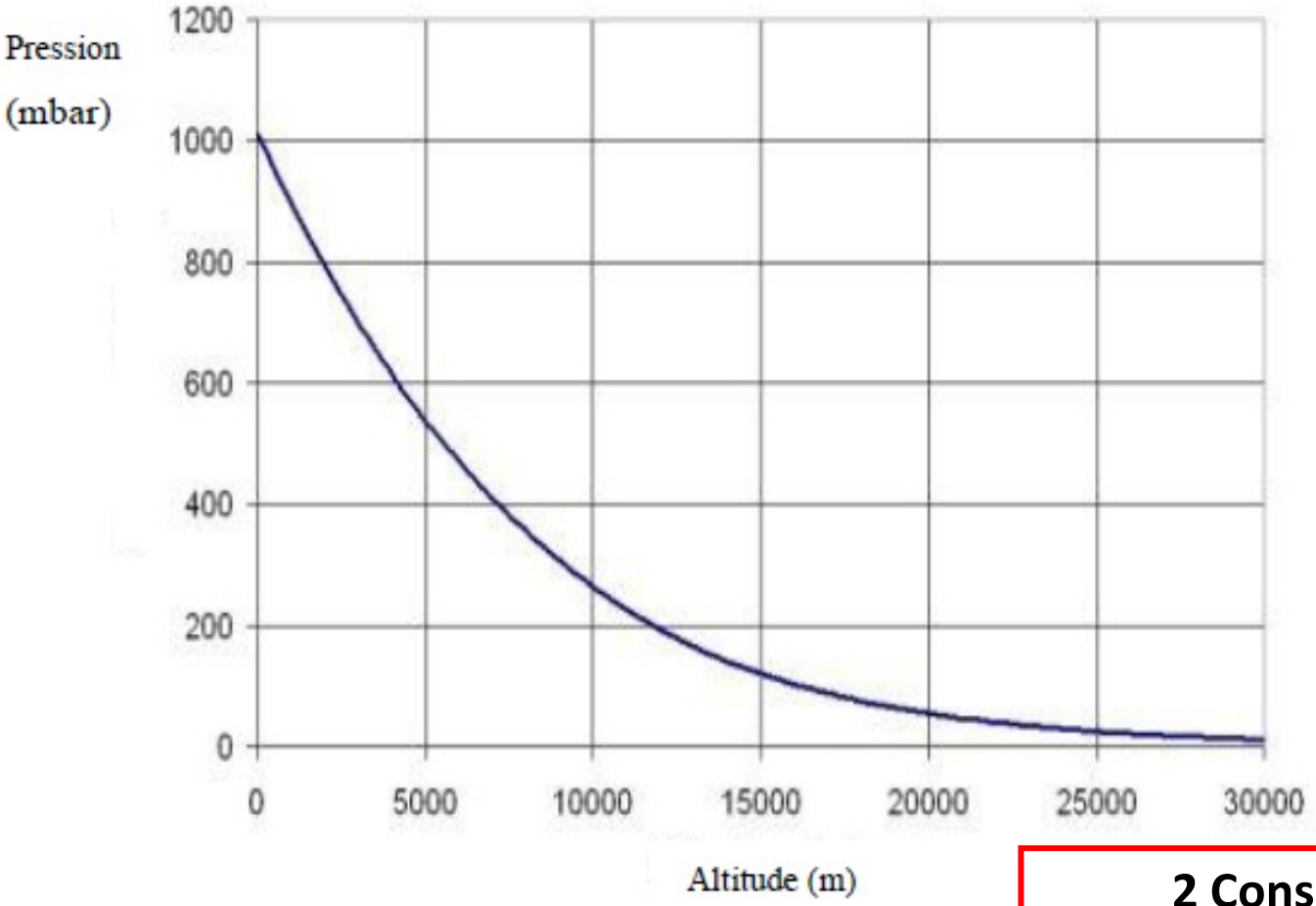
# What are the specific constraints ?

- Related to altitude
  - Dysbarism : expansion of enclosed gas
  - Hypobaric hypoxemia
- Related to the flight
  - G-forces
  - Sickness
- Related to the cabin ambiance
  - Noise
  - Vibration
- Isolation

# Altitude - Pressure




**2 Consequences**

**Dysbarism**

**Hypobaric hypoxemia**

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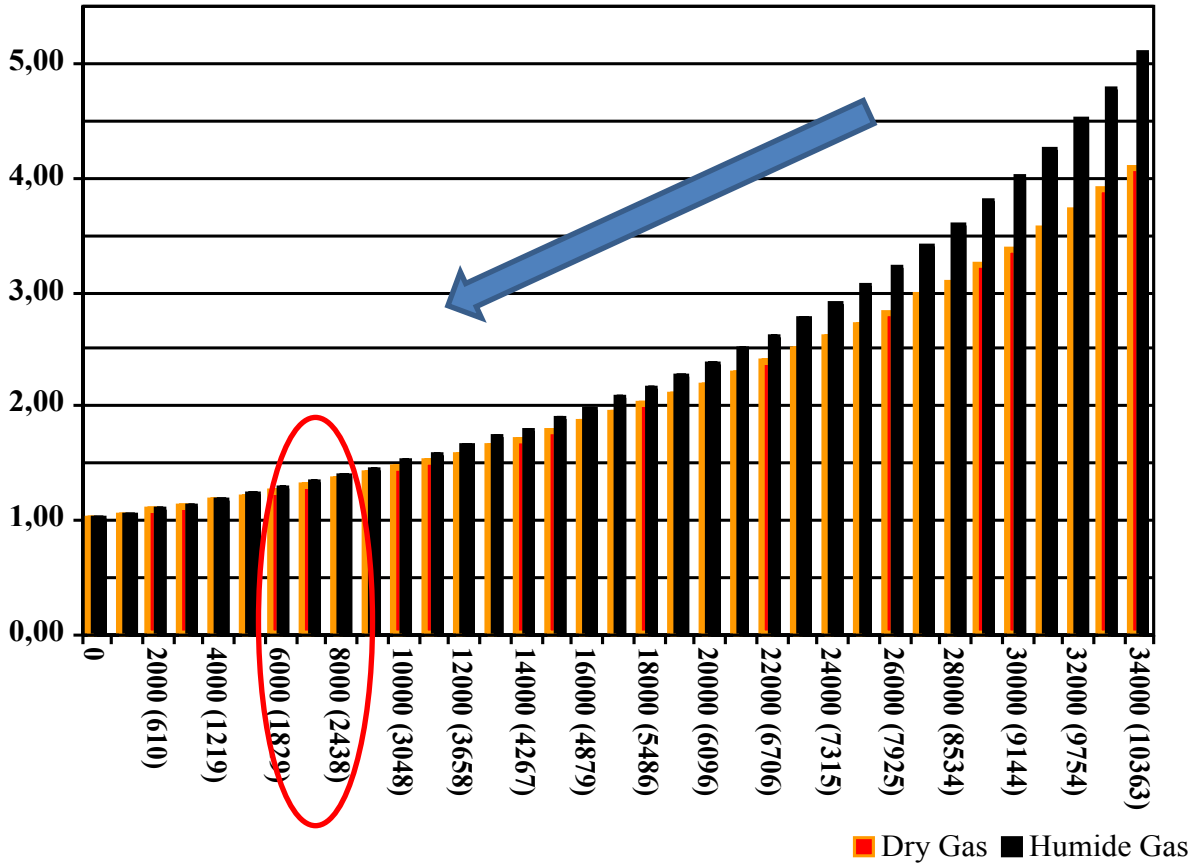
# Cabine Pressurization

Gas expansion




Altitude

1 Ft=0,3 m

1 m = 3,28 Ft

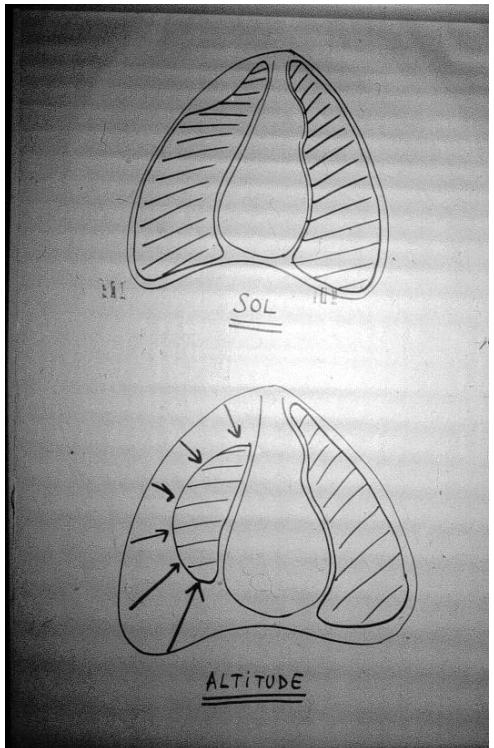
Cabine Altitude → Volume x 1,2

# Altitude - Dysbarism and pneumothorax

Boyle's law

$P.V = k$

Gas volume varies inversely to pressure




Chest tube drainage BEFORE the flight

Risk = gas tamponade

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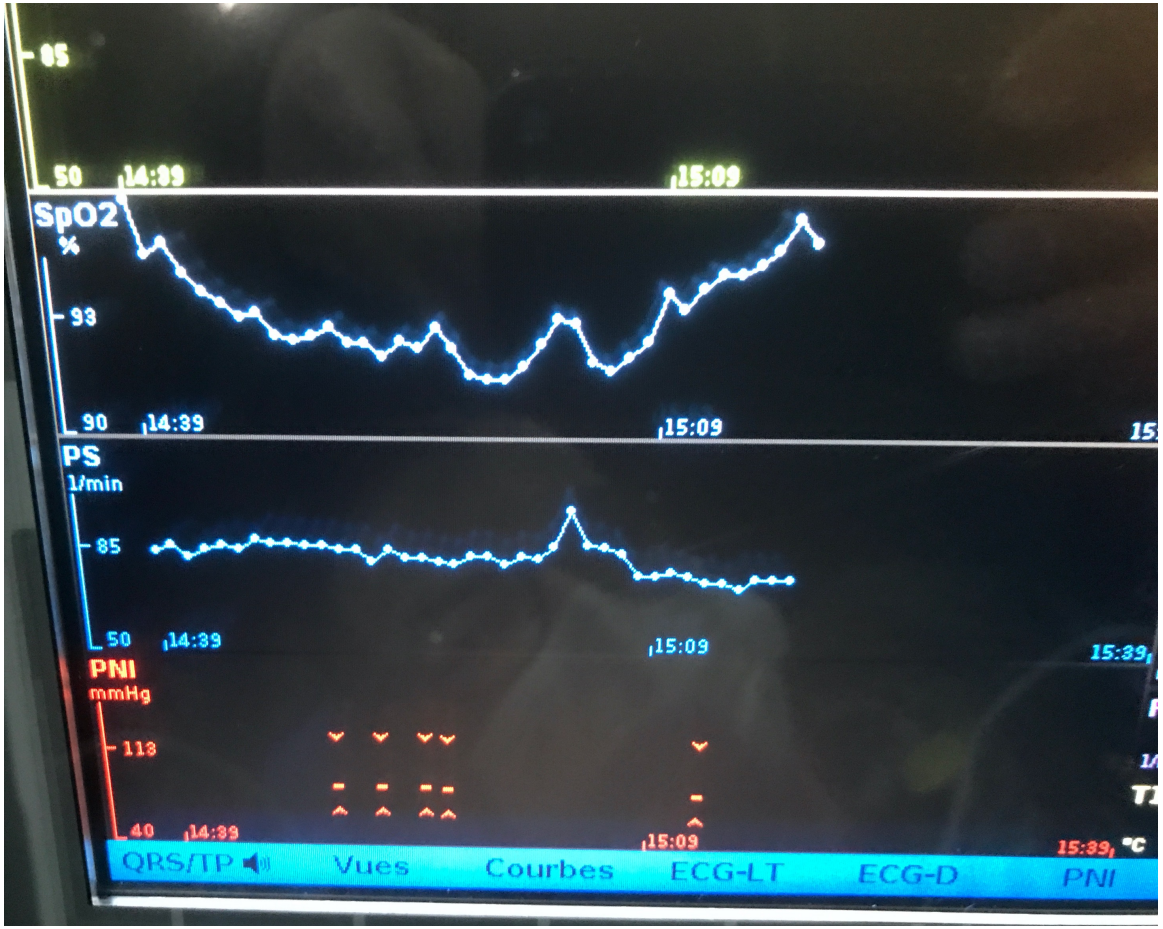
# Altitude - Hypobaric hypoxemia

Dalton’s law and Henry’s law

Low pressure -> low $PalvO_2$ -> hypoxemia

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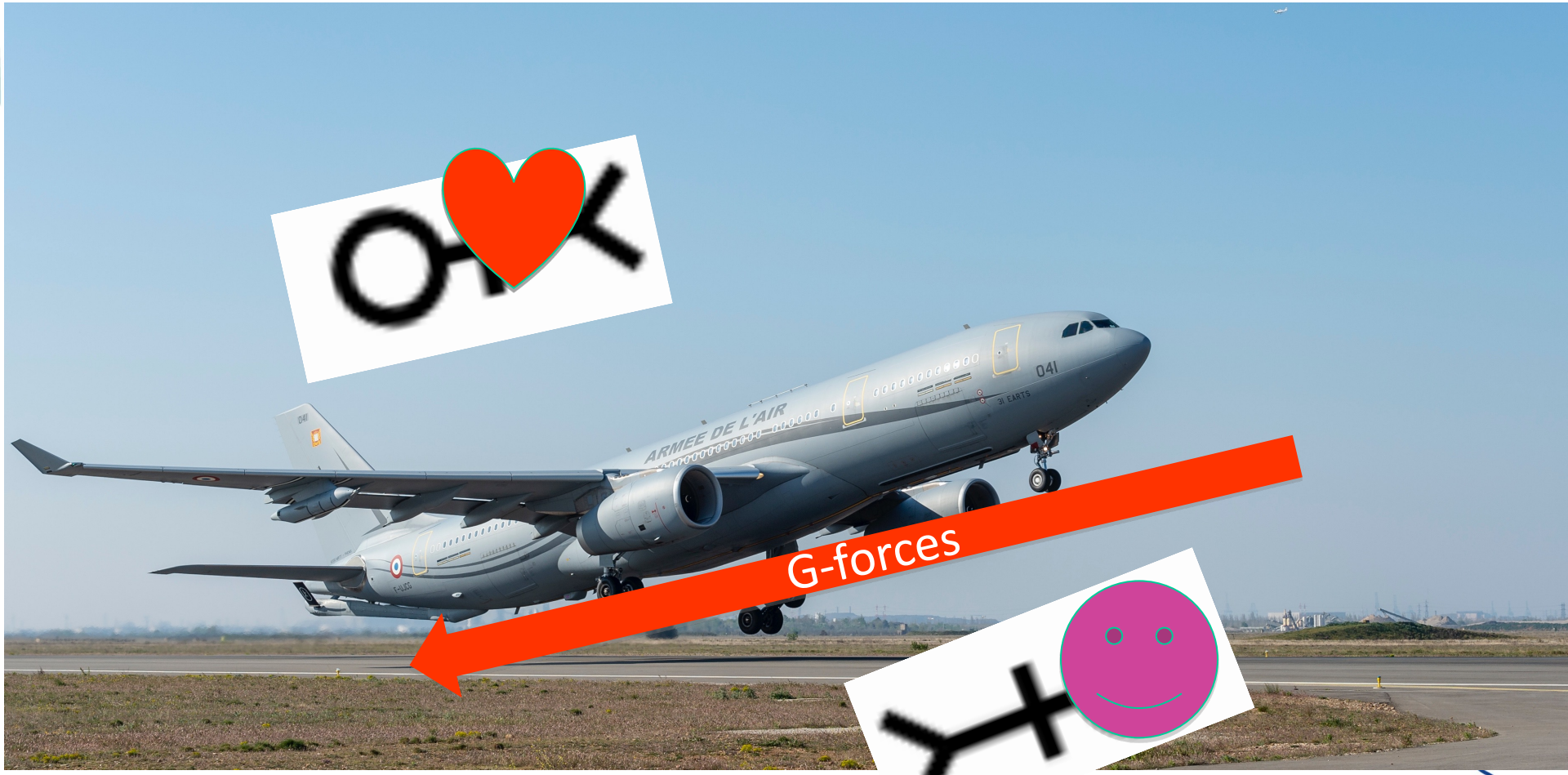
# Altitude - Hypobaric hypoxemia

- Little consequences for the well being person (crew member = asthenia)
- Little consequences = Patient under mechanical ventilation
- Anticipation is required for the patients with respiratory dysfunction who is not under mechanical ventilation

# Flight - G - forces

**Take-off**



# Constraints due to cabin ambiance

- Noise
  - Alarm
  - Physical examination

- Vibration
  - Risk of material projection
  - Premature dysfunction of the medical devices

# Isolation = Anticipation
# Is this patients OK to flight?

- Haemorrhagick shock, splenectomy

- Tachycardia
- Haemoglobin is going down, lactate is going up
- NORepinephrin is going up

- 8 hours-flight to go

# Isolation = Anticipation
# Is this patients OK to flight?

- Surgical hemostasis must be achieved
- Airway must be secured
- Gas tamponnade must be prevented

# Ergonomy


Boarding plan

Secure patient and devices

Prefer
Access to the head

Access to chest tube drainage

Access to dressing

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# During the flight

Less is more

- Ongoing DCR
  - catecholamine, transfusion,…
- Intensive care
  - Sedation, ventilation, preventing nurses (eschar…)
  - Intracranial pressure monitoring
  - Analgesia (locoregional…)

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# Conclusion – Take-home message

**Anticipation**

The success is achieved before take-off

Causes of avoidable mortality must have been fixed before the flight

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