Medications in cardiology and scuba diving
Pacemakers and scuba diving

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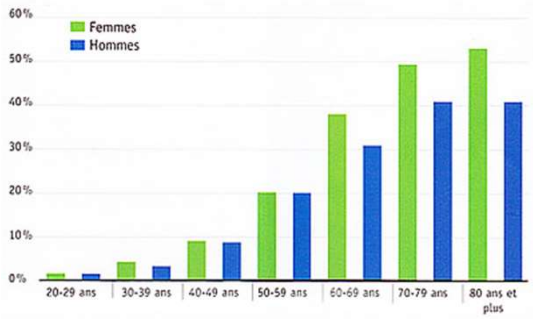
Conflicts of interest :

- Nihil

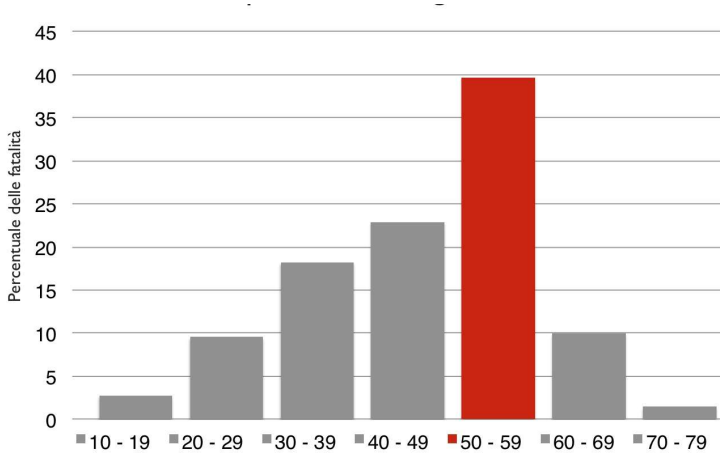
EPIDEMIOLOGY

- In France: average age of divers between 2010 and 2015 : 38 to 41 years
- In Europe : average age of divers : 46 to 50 years (DATA from DANEUROPE)
- Since 10 years the number of divers over 60 years: X 3 for men and X 5 for women
- The average age of divers enrolled in LIFRAS in 2017 is 48 years.
- High blood pressure is the most common cardiovascular disease.

Prevalence of hypertension according to age



Accidents by age group (daneurope)



- High blood pressure often leads to multiple medications (2 to 5)
- High blood pressure is often associated with other diseases requiring treatment
- => Many divers take one or more medications
- Are these treatments suitable for diving ?

Physiopathology

- During immersion, the diver will be subjected to various factors that will affect the functioning of the cardiovascular system :
  - ↗ of the ambient pressure
  - ↗ density of inhaled air
  - Cold
  - The stress
  - Physical effort
  - ↗ of the partial pressure of the inhaled gases

- As a result, several parameters of the cardiovascular system are modified:
  - Blood pressure, vascular distribution, vascular permeability
  - Heart rate,
  - Blood viscosity,
  - Acid-base balance (biochemistry)

Cardiovascular Medications

Beta-Blockers

Indications :

- HBP
- Ischemic heart disease
- Chronic heart failure
- Arrhythmias
- Hypertrophic cardiomyopathy
- Tremors, hyperthyroidism, migraine, glaucoma

Interactions on the cardiovascular and respiratory system :

- Bradycardia => poor adaptation of the heart rate to the effort
- Reduced cardiac contractility => increases the risk of immersion pulmonary edema (IPE)
- Peripheral vasoconstriction: poor cold tolerance, vascular redistribution => increased risk of IPE
- Bronchial hyperreactivity

4 good reasons to avoid taking a beta blocker :

1. Risk of bronchospasm
2. Aggravation of the effect of cold
3. Poor adaptation to the effort
4. Risk of IPE

1 Good reason to take beta blockers :

Hypertrophic cardiomyopathy

Recommendations :

If treatment is unavoidable (arrhythmia, severe hypertension, coronary insufficiency, glaucoma, ...) :

- Focus on Cardio-selective beta-blocker
- A rest and exercise ECG is indicated every year from the age of 40 years
- Possibly reconsider the aptitude for diving

Good to know :

- Very bad idea to interrupt a beta-blocker treatment just for diving.
- Bb are part of the drugs considered as doping and are therefore prohibited for sports competitions (apnea)

Calcium Channel Blockers :

Indications :

- Hypertension
- Coronary diseases

No contraindications but rather disadvantages: poor adaptation to cold, palpitations

Avoid molecules that slow down the heart rate (Isoptine and Tildiem) because of the risk of discomfort

Diuretics

Indications :

- Hypertension
- Heart failure : in this case diving is contraindicated

Consequence of treatment with diuretics :

- Dehydration => increase in blood viscosity => increased risk of decompression sickness

(As a reminder: immersion induces itself a diuretic effect)

- Potassium loss => increased risk of potentially dangerous heart rhythm disturbances for diving

➔ *Diuretics are not recommended for diver and if they are indispensable the doses must be reduced*

Inhibitors of the renin-angiotensin system (IEC & SARTANS)

Indications :

- Hypertension
- Heart failure : in this case diving is contraindicated

☺ Ideal treatment for blood pressure for divers ☺

Possible side effect of ACE inhibitors = irritative cough => then go to the Sartans

Blood Thinners

- = NOAC (Pradaxa, Eliquis, Lixiana, Xarelto); anti-vitamin K (Sintrom) and anti-platelet aggregates (Aspirin, Plavix, Effient, Brilique)
- Do not constitute a contraindication to diving
- Ability to dive rather from the disease justifying this type of treatment
- Sintrom OK if INR between 2 and 3 (if INR must be > 3; e.g. some mechanical valves) => no more diving

Risks for diving :

Excessive bleeding can occur :

Often not serious : ENT sphere if barotrauma; Eyes if mask veneer

Serious if decompression illness occurs in the brain or spinal cord

=> Avoid deco and/or deep diving with NOAC

Whether or not to give aspirin as a diving accident :

- *Not recommended by LIFRAS and PADI*
- *Recommended by FFESSM for all decompression accidents and pulmonary barotraumas (500 mg for adult divers)*
- *Contra : => giving aspirin is a medical act*
  => many people are allergic and do not necessarily know it
  => there is no scientific study which formally demonstrates the interest in the event of decompression sickness
  => hemorrhagic risk especially in case of damage to the central nervous system

Antiarrhythmic Drugs

The pathology related to taking the drug must above all be compatible with diving

1. Class 1 : (Flécaïnide) : Caution < cause of significant proarrhythmogenic effects.
2. Class 2 : See beta-blockers
3. Class 3 : (Amiodarone) : photo-sensitivity of the skin, pulmonary fibrosis (follow up by spirometry)
   Nb : If treatment for the regularization of atrial fibrillation => Temporary contraindication for diving

4. Class 4 : see Calcium Channel Blockers
5. Class 5 : (Digitalis) :

- To slow down atrial fibrillation
- Avoid because therapeutic dosage is difficult to be balanced
- Prefer anti-calcium slowing heart rate

Lipid-lowering agents:

- Statines may cause myalgia
- Consider cardiovascular risk instead

Drugs incompatible with diving:

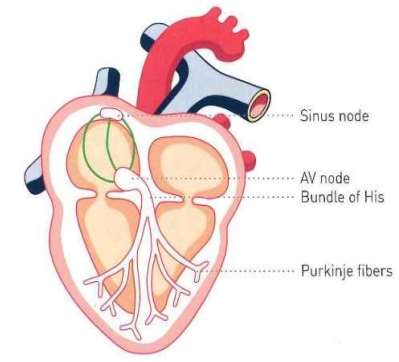
- Antianginal drugs (Cédocard, Ivabradine,…)
- Drugs for pulmonary arterial hypertension

Pacemakers and scuba diving

Introduction

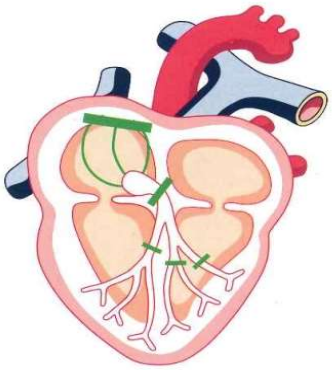
- 2 million people in the world
- In the past : only purpose to save lives
- Today : able to work, to travel and to engage in athletic exercices

Physiological reminder



The cardiac conduction system of the heart

Biotronik

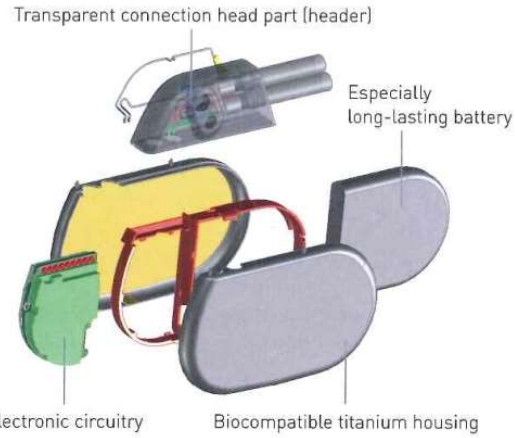


With the help of a pacemaker system, carefully calibrated electric pulses stimulate the heart muscle in such a manner that the heart rhythm is once again similar to that of a healthy heart.

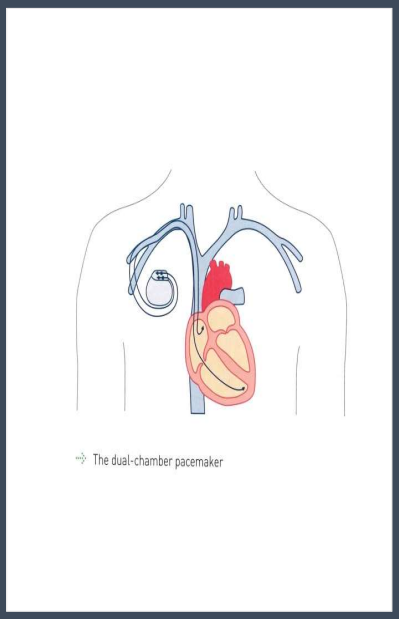
Biotronik

The pacemaker

- Modern pacemaker can be adapted to any specfic malfonction of the heart.
- They consist of the pacemaker and the leads connected to it.
- The pacemaker contains miniaturized electronic circuitry and a battery
- It becomes active whenever the patient exhibits a disturbed heart rythm.



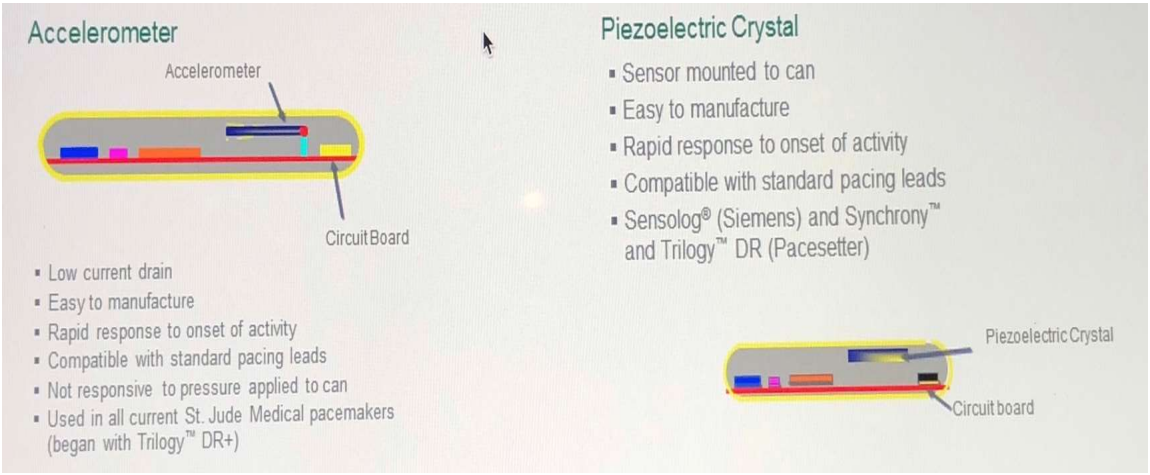
The pacemaker



The dual-chamber pacemaker

- The connection between pacemaker and heart is established by one or two leads
- A lead is a very thin, electrically insulated wire that is anchored in the right atrium or the right ventricule
- The activity of the two chambers are synchronized, and optimal contraction of the heart muscle is ensured

Rate response



Pacemaker for divers

- ONLY St Jude Medical (Abbott) have been tested to an absolute level of 7 atmosphères (60 m deep) with no effect on device function.
- Pacemakers manufactured by other companies only support up to 4 bar pressure
- The FFESSM limits diving to 30 meters in implanted subjects
- No diving is recommended, in case of pacemaker-dependence

Implanted Internal Defibrillators

For patients that are a high risk of ventricular tchycardia, ventricular fibrillation or other rhythm defects that can lead to sudden cardiac arrest ➔ these implanted devices are not recommended for divers.

Conclusions

- First, we must ask ourselves if the disease is compatible with diving
- Avoid medications that interfere with heart rate or that affect breathing (e.g. : Beta blockers)
- For arterial hypertension: prefer IEC / SARTANS and anti-calcium or small doses of diuretics
- In case of medication requests, it is necessary to be regularly followed by a competent doctor in hyperbaric medicine and to make 1 stress-test (ECG) every year from the age of 40 years

- Anti-arrhythmics are allowed if the arrhythmia is chronic and stabilized
- If a pacemaker should be implanted and there is no complete dependence on the pacemaker: choose St Jude Medical Brand
- The devices "rate response" can not be of type: Piezoelectric Crystal (Old pacemaker)

Thanks for the documentation :

- DAN EUROPE
- St Jude Medical (Abott)
- Biotronik