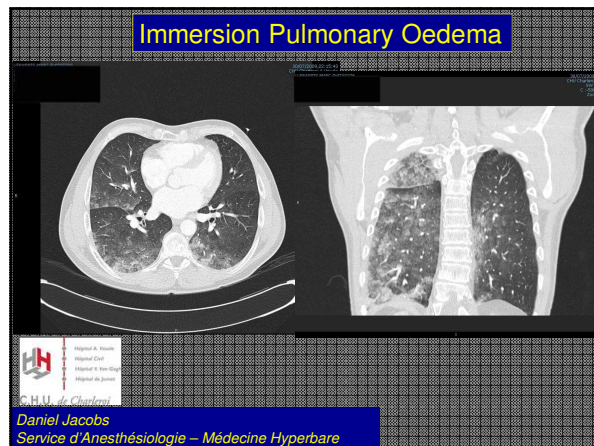




Immersion Pulmonary Oedema

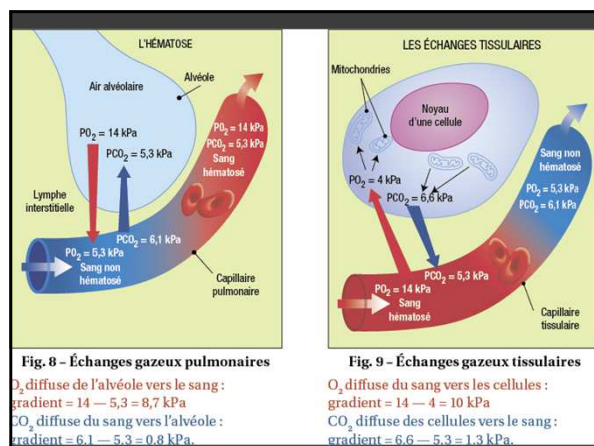
- New discovered pathology
- Poor understood - Difficult medical diagnosis
- High risk diver – Well trained subjects
- Risk of death at emersion or at hospital
- Unknown risk of Reoccurrence
- Specialized medical follow-up

What is a Pulmonary Oedema ?

Accumulation of PLASMA in the air space

With or without Red blood cells

Resulting from DYSFUNCTION of
Alveolo-capillary membrane
and / or
Heart Failure



Article original

L'œdème pulmonaire en plongée sous-marine autonome : fréquence et gravité à propos d'une série de 19 cas
Pulmonary oedema in scuba-diving: Frequency and seriousness about a series of 19 cases

A. Henckes, F. Lise, G. Cochard*, J. Arvieux, C.-C. Arvieux
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Disponible sur Internet le 31 juillet 2008

Œdèmes pulmonaires d'Immersion
Un accident de plongée « récent » et potentiellement grave... voire mortel !
Réunion du 6 novembre 2010
Dr Pierre LOUGE
Service de Médecine Hyperbare et d'Expertise Plongée
Hôpital d'Instruction des Armées Sainte-Anne

Case reports
Two fatal cases of immersion pulmonary oedema – using dive accident investigation to assist the forensic pathologist
David R Smart, Martin Sage and P. Michael Davis

Lancet. 1989 Jan 14;1(8629):62-5.
Cold-induced pulmonary oedema in scuba divers and swimmers and subsequent development of hypertension.
Wilmshurst PT1, Nuri M, Crowther A, Webb-Peploe MM.

Diagnosis of Swimming Induced Pulmonary Edema – A Review
Hermes Grigg¹, Paraskevi T. Nikolaidou², Richard E. Moon³ and Beate Knechtle^{4,5,6}
¹Institut für Rettungs- und Notfallmedizin, Luzern, Switzerland; ²Emergency Physiology Laboratory, Weiss, Germany; ³Center for Respiratory Medicine and Environmental Physiology, Department of Pathology, Queen's University Belfast, Queen's University, UK; ⁴United States; ⁵Geonutritionlabor, St. Gallen, St. Gallen, Switzerland; ⁶Institute of Primary Care, University of Guelph, Guelph, Switzerland

2002 : First medical recurrence and fatal case - Brest
2005 : 6 recurrence reports – 1 death
CHU Vésale : 6 cases since 2006 – No deaths

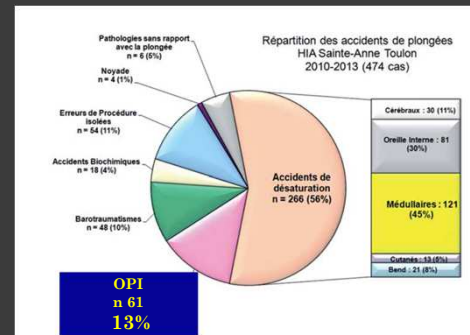


Figure 5. Répartition des accidents de plongée dans le Var sur la période 2010-2013.

- Wilmshurst PT, Nuri M, Crowther A, Webb-Peploe MM. Cold-induced pulmonary oedema in scuba divers and swimmers and subsequent development of hypertension. *Lancet* 1989;1:62-65.
- Pons M, Blickenstorfer D, Oechslin E, Hold G, Greminger P, Franzeck UK, et al. Pulmonary oedema in healthy persons during scuba-diving and swimming. *Eur Respir J* 1995;8:762-7.
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- Hampson NB, Dunford RG. Pulmonary oedema of scuba divers. *Undersea Hyperb Med* 1997;24:29-33.
- Slade JB, Hattori T, Ray CS, Bove AA, Cianci P. Pulmonary oedema associated with scuba diving. *Chest* 2001;120:1686-94.
- Mahon RT, Kerr S, Amundson D, Parrish JS. Immersion pulmonary oedema in special forces combat swimmers. *Chest* 2002;122:383-4.
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- Wilmshurst PT. Pulmonary oedema induced by emotional stress, by sexual intercourse, and by exertion in a cold environment in people without evidence of heart disease. *Heart* 2004;90:806-7.
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- Moon RE, Martins SD, Poucher DF, Kraus WE. Deaths in triathletes: immersion pulmonary oedema as a possible cause. *BMJ Open Sport Exerc Med* 2016;2:e000146.
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- Shupak A, Guralnik I, Keynan Y, Yahir Y, Adir Y. Pulmonary oedema following closed-circuit oxygen diving and strenuous swimming. *Aviat Space Environ Med* 2003;74:1201-4.

What happened during dive ?

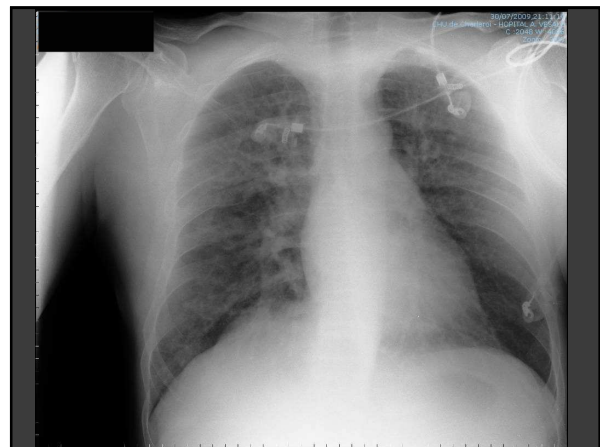
55 years old male diver – Padi advanced – 500 dives
Dive profile : 31 meters – 35 minutes – safety stop 5min-5m
Breathlessness during the safety stop – End of diving
Unable to reach the pontoon

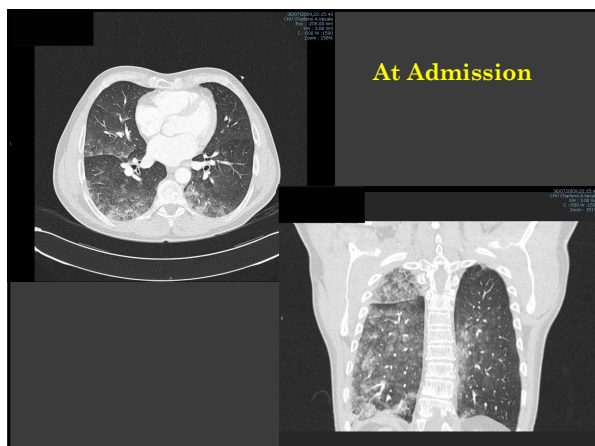
In the emergency room

Tachycardia 120beats/minute
Dyspnea – Polypnea
No thoracic pain
Lung auscultation : wheezing – crackling sounds

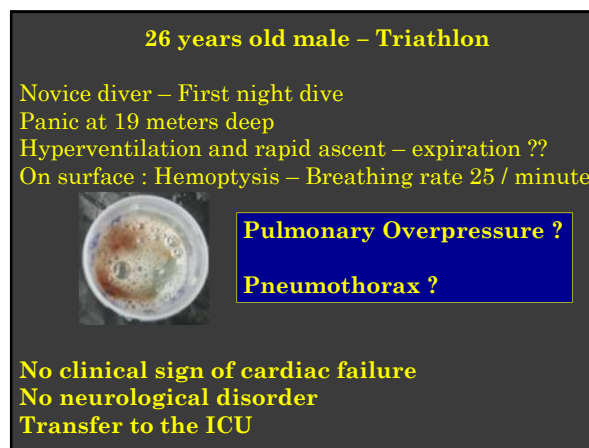
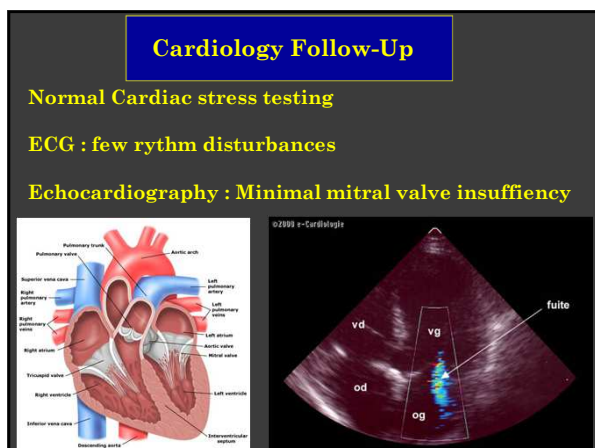
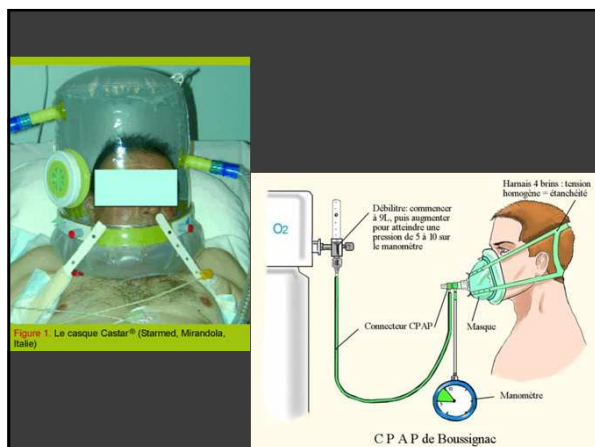
Absence of any neurological disorders

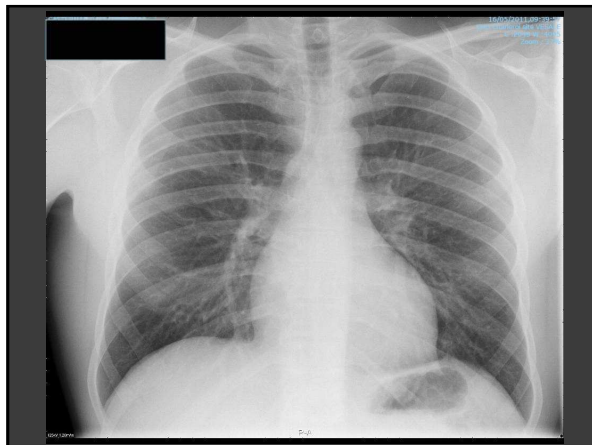
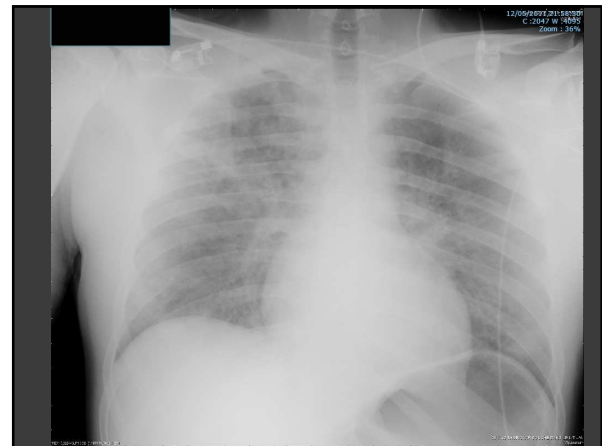
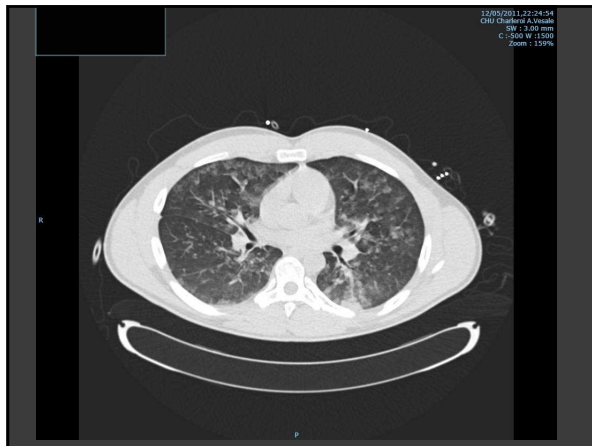
No indication of hyperbaric treatment





	Non RB Mask 2 heures post accident	CPAP 5 cm H2O 3 heures post accident	CPAP 5 cm H2O 8 heures post accident	Vmask 12heures post accident	Air Ambiant 24heures post accident
FiO2	100%	100%	100%	50%	21%
pH artériel	7,38	7,39	7,38	7,41	7,36
PaO ₂	76	107	147	116	89
PaCO2	47	44	45	42	35
Bicarbona te	26,2	26,6	26,6	26,2	24,4
CO2 total	27,7	28,2	28	27,1	25,8
Excès de Base	0	-1	01	2	0
Sat en O2 de Hb	94	94	98	99	95
Troponine	0,1		0,49	0,3	0,15

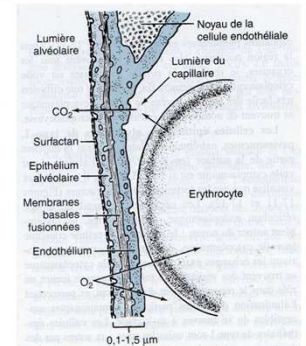




VIII – Histophysiologie

1 – Barrière alvéolo-capillaire

- 100 m² de surface alvéolaire et 95 m² de surface capillaire
- Epaisseur très mince 0,1 à 1,5 µm
- Constituée de :
 - Surfactant
 - Pneumocyte I
 - MB fusionnées
 - Cellule endothéliale

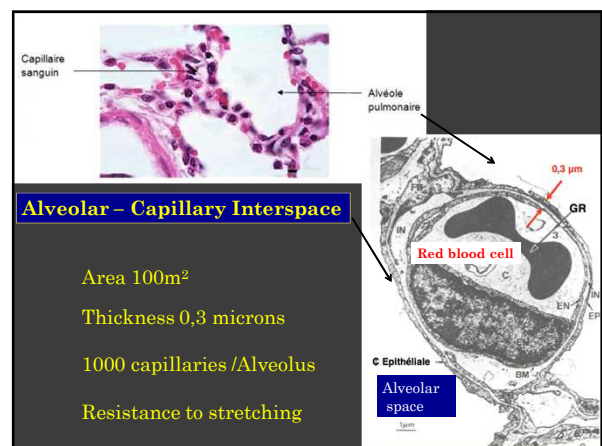


What is a Pulmonary Oedema ?

Accumulation of PLASMA in the air space

With or without Red blood cells

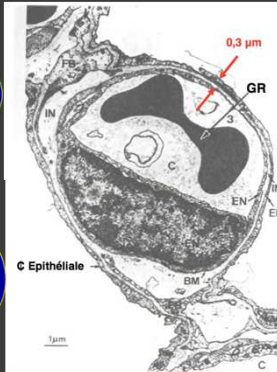
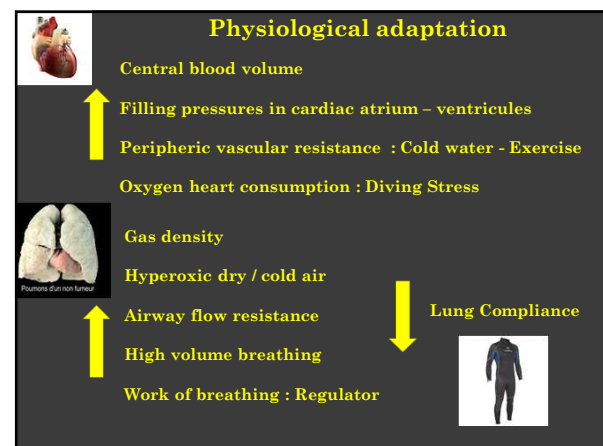
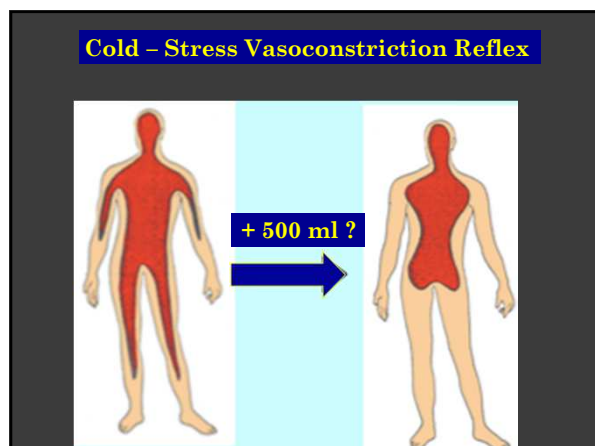
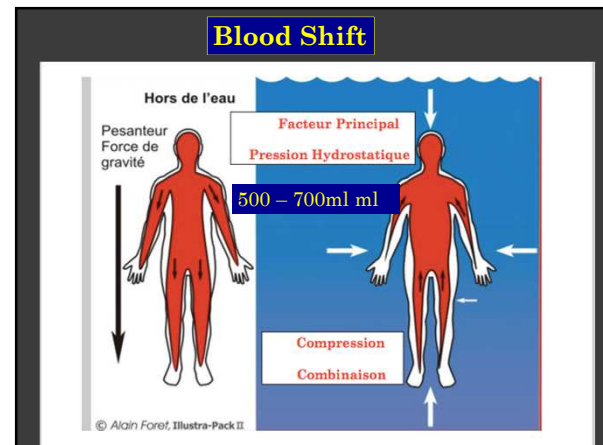
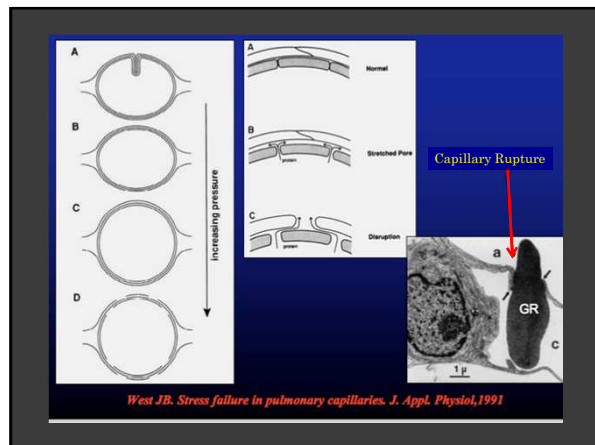
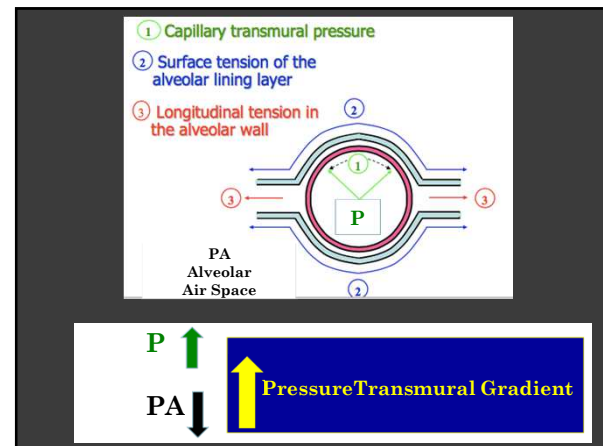
Resulting from DYSFUNCTION of
Alveolo-capillary membrane
and / or
Heart Failure

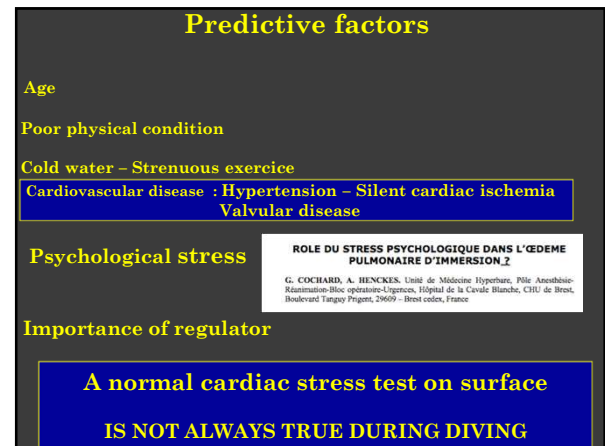


The surprising thing is not that capillaries fail,
But they do not so more often (West – Lancet 1992)

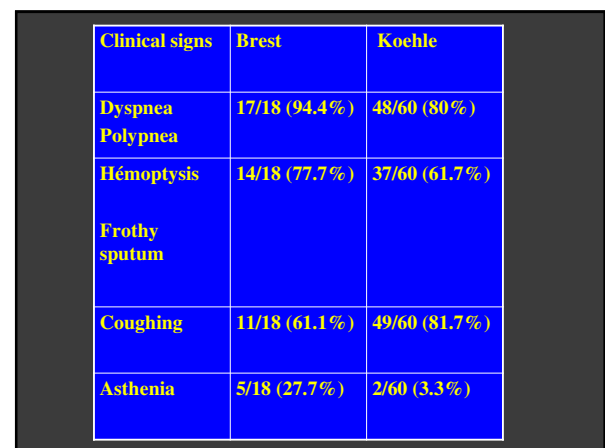
Small Thickness
↓
Gas Exchange

Resistance to
Rupture
Plasma transfer

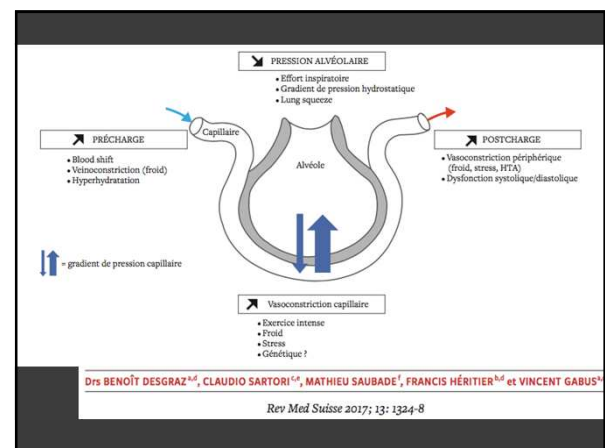
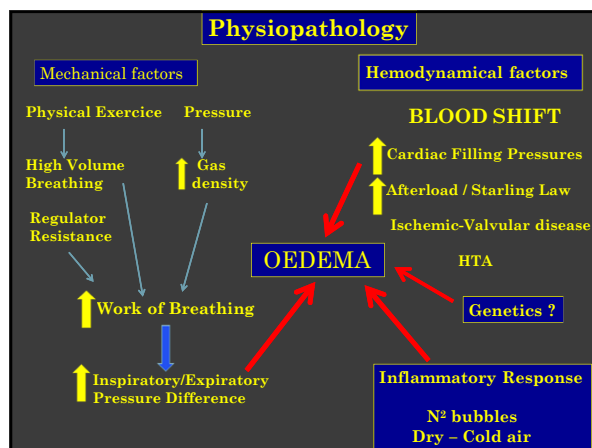
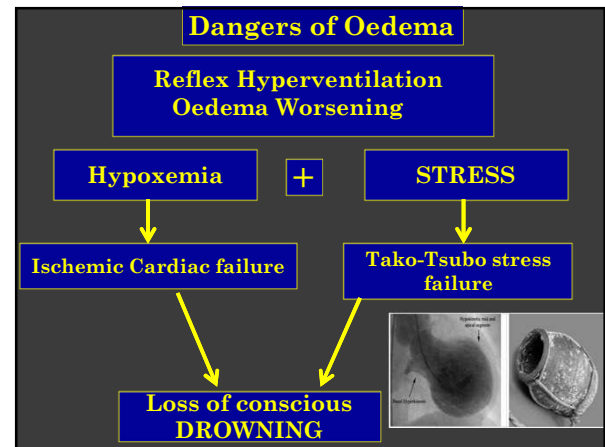
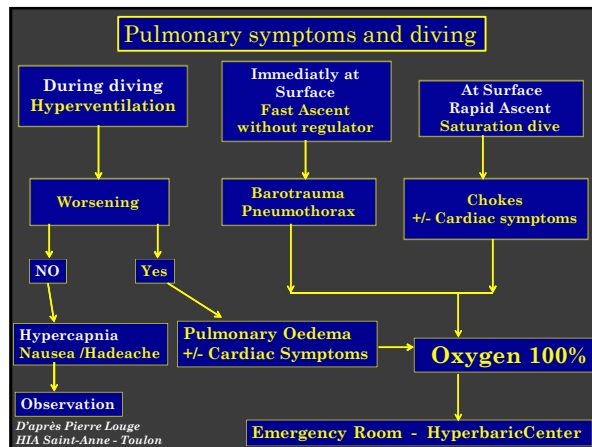
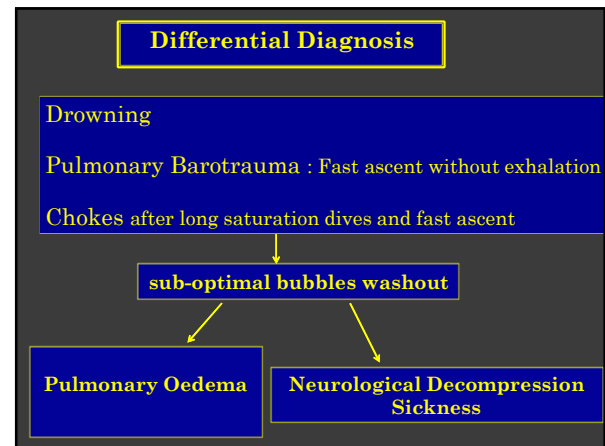


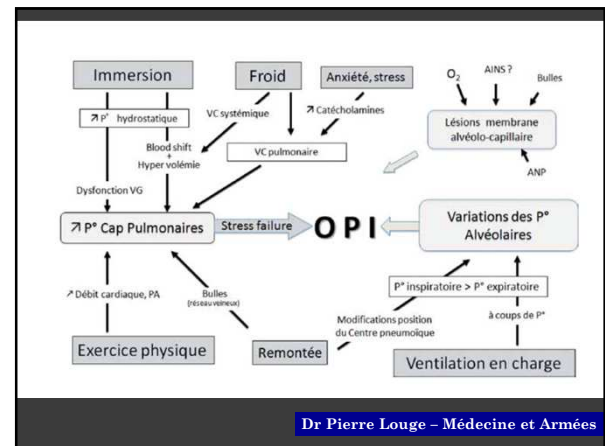
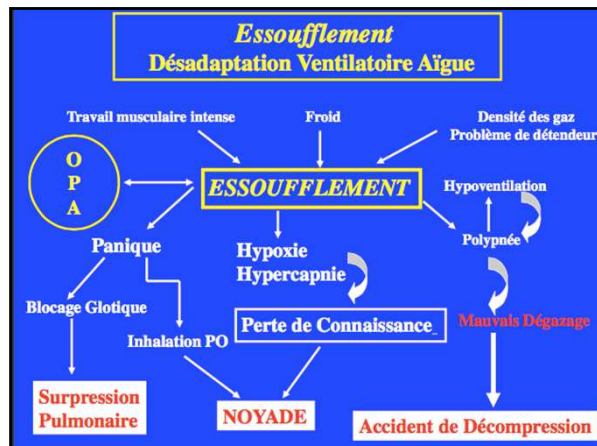
The diagram illustrates the normal physiology of the heart and lungs. It shows the pulmonary circuit (top) and the systemic circuit (bottom). The pulmonary circuit consists of the pulmonary artery (artère pulmonaire) and the pulmonary veins (veines pulmonaires). The systemic circuit consists of the aorta and the vena cava (OD and VD). The flow in the pulmonary circuit is labeled as Flow 2, and the flow in the systemic circuit is labeled as Flow 1. The diagram shows that Flow 1 equals Flow 2, indicating that the flow is the same in both circuits. The flow in the pulmonary circuit is 5 l/min, and the flow in the systemic circuit is 5 l/min. The diagram also shows the relationship between the flow in the pulmonary circuit and the flow in the systemic circuit, with the equation $1 = 2$ indicating that the flow is the same in both circuits.



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Cases 19	Man 15 (79%)	Woman 4 (21%)
Mean age	53	
Hypertension	42	
Valvular disease	26	
Smoker	1	
Mean Depth / Min	24 m / 21 min	
Water T°	10 - 17°C	
Physical exertion	All divers	
Stress		
Dyspnea-Polypnea	All divers	
Hemoptysis	14 / 19	
Frothy sputum		
Coughing	10 / 19	
Loss of conscious	3	





Treatment

Stop the dive

Slow ascent - Respect of decompression stop ??

Sitting position

Ask for OXYGEN

Alertez le DAN

And once more

In the hospital

Classic CPR

Chest CT Scan

Laboratory parameters – Cardiac enzymology

Intensive care unit admission

Supportive O₂ administration : CPAP / Press Support V^olation

Cardiac support

Caution with diuretics

HBO if DCS symptoms

Cardiovascular Investigation

Caution for return to diving

Questions pour un Champion

When to realize a blood shift

In case of emergency ?

Autotransfusion

Passive transfer of 500 – 700 ml blood

Décubitus dorsal

Lever de jambes 45°

Blood Hemorrhage

In the intensive care unit – Operating room

Increase of Cardiac Blood Flow and Blood Pressure

